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ENVIRONMENTAL BASIS
OF SOCIAL GEOGRAPHY

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TO
S. B., R. I. AND F. M.

14667

PREFACE

Modern geography considers man the central theme of its study of the earth. However, as Professor Mark Jefferson says: "Geography is not to be regarded in its human aspects as the story of Earth and Man, but as the study of Man using and living on the Earth."

This book attempts to give to the college and university students beginning the old subject of geography perhaps not altogether a new point of view, but rather a new organization of the material, in accordance with this modern viewpoint that geography is concerned with the relations between man and his environment.

Basing the classification of the subject upon this fundamental geographic principle of relationship, the development of which is traced in Chapter I, the text then proceeds upon two other basic principles of geography: first, that this relationship is reciprocal—that is, not only does the environment influence human affairs, but also man modifies his environment; second, that the two sets of factors thus geographically related—that is, human affairs on one side, and environmental elements on the other—are both subject to continual change, and that, therefore, the nature of man's adjustment to his environment must differ essentially at different times and in different places.

Throughout the book, the endeavor has been to develop the subject logically and consistently with the foregoing principles, and not to give the student the notion that environment determines everything, since there are always other factors, heredity, training, and so forth.

As the student should not be expected to make effective geographic correlations between human affairs and environment without knowing something about both, a brief outline of man's distribution and activities in Chapter II and a classification of the elements of environment in Chapter III precede the more detailed analysis of the environmental factors and the interpretation of their human relationships which follow. The last chapter sketches briefly the account of the slowly but gradually increasing control over nature which marks man's progress towards civilization.

The introduction of chapters on the use and interpretation of maps, seasons as geographic factors, and land utilization, particularly in urban geography, was the result of an attempt to place the text in line with the modern trend of geographic thought.

It is believed by the authors that the study of the many environmental factors and the consideration and evaluation of their varied geographical relationships will give the student training in logical thinking; that considerable planned repetition throughout the book has the pedagogical advantage of helping to fix the facts and principles in his memory; and, finally, that the increased knowledge thus gained of various people in various regions and the resultant differences in their natures, habits, accomplishments, and opportunities will not only develop in the student the quality of accurate imagination, but will also contribute to his sympathetic understanding of people in other regions.

The authors are unable here to name all the many writers and books to whom they are deeply indebted. Some specific references will be found in the footnotes. Mention should be made, however, of certain texts, as Gregory, Keller, and Bishop's "Physical and Commercial Geography," Salisbury, Barrows, and Tower's "Elements of Geography," Jones and Whittlesey's "Introduction to Economic Geography," and, of course, Miss Semple's "Influences of Geographic Environment," the publications of which marked an important step in the progress of college geography-teaching in this country.

Acknowledgment is here made also of the kindness of the editors of the *Journal of Geography*, *Social Science*, and *School and Society* in permitting free use of certain of the authors' articles which appeared in those publications; also of the kind help of many United States Government Departments and

Bureaus in supplying material and particularly maps and photographs. Our thanks also go to our colleagues, Mr. L. D. Jones of the Department of Engineering Drawing and Mr. H. G. Brunsman of the Bureau of Business Research of the Ohio State University, for their efficient work and kind assistance in connection with the maps and diagrams which appear throughout the book. Nor should we forget the former geography students upon whom the material of the book has been tested.

C. C. H.
F. A. C.

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ENVIRONMENTAL BASIS OF SOCIAL GEOGRAPHY

CHAPTER I

NATURE AND CLASSIFICATION OF GEOGRAPHY

Changing Conceptions of the Field of Geography.

The principle of change.—Geography is a dynamic science. Activity or change is one of its most fundamental principles. This is true not only of the material with which it is concerned, but also of the conception of its field, function, and definition, as held by the workers most distinguished in the field. In the long run the definition, purpose, and divisions of geography are established or modified according to the views or interest of the authorities in the subject, allowing, of course, for certain environmental influences, as it were, in the way of limitations due to similar activities on the part of workers in related fields, whose right to endeavor to fix the boundaries of their subjects is equally well recognized.

Stages in the Development of Geography.

The descriptive stage of geography.—So we find the prevailing conception of geography quite different now from what it was, say, seventy-five years ago. At that time geography, it may be said, was still in the *descriptive stage,* and it was usually defined as a description of the earth on which we live. This stage had not changed much from the time of Columbus and the resulting age of exploration and discovery, when the location and description of an increasing number of places gave the color to what was often called "sailor geography." Even after the Civil War in the United States, geography was still in the descriptive stage. The subject was then commonly classified in three branches: mathematical, physical, and political.

Distribution stage of geography.—A little later the subject passed into a period in which many of the workers in the field were fond of calling it the science of distribution, the characteristic purpose of geography then being considered to be that of accounting for the location of places and things upon the earth. Thus, in 1881, the International Geographical Congress at Venice formulated a definition which stated that "Geography includes the study of the surface forms of the earth and the reciprocal relations of the different branches of the organic world" and is distinguished from other sciences by "indicating the distribution of beings organic and inorganic upon the earth;" and in 1899 "The International Geography" defined the subject as "the exact and organized knowledge of the distribution of phenomena on the surface of the earth, culminating in the explanation of the interaction of man with his terrestrial environment." This idea of distribution as the distinguishing characteristic of geography still lingers in some quarters, notably in England, as may be seen in Herbertson's definition, or in that of Hogarth, both prominent English geographers. A recent definition of Sten de Geer, a leading Swedish geographer, is another instance of this view.

The physiographic stage.—According to the dictionary it is the business of the geographer to write about the earth, and the etymology of the word (Gr. *geos*—the earth, and *graphos*—to write) seems to justify that point of view. So, at one time, and that before the distribution phase of geography had become very widespread, it seemed to be the opinion in many quarters that geography had chiefly to do with the physical features of the earth's surface, with the location, classification, and causal explanation of the various forces, processes, and forms of earth phenomena. As early as 1892 Professor William M. Davis of Harvard University referred to "the increasing attention given in recent years to physical over simply descriptive and political geography." For a number of years, this phase of the subject had quite a vogue, but as an earth science purely, it was thought that the study tended too much toward physiography, which is properly a branch of geology. Prominent geography teachers soon noted this extreme tendency and pointed out that the earth included man. Thus, Professor Ralph S. Tarr of Cornell University, defining geography as "a study of the earth as the home of man," declared in 1900: "I do not believe that the teacher of geography has any right to treat of young, mature and old valleys; nor of the destruction of lakes by filling; nor any other purely physiographic principle or phenomenon for the sake of the thing itself."

The biogeographic stage of geography.—Consequently, in this country early in the twentieth century, largely due to the influence of Professor W. M. Davis, the subject entered what might be called the environmental or biogeographic stage. Dr. Davis proposed to define geography as "the relation between the earth and its living inhabitants, between the physical environment and the environed organism," that is, a combination of physiography, which deals with the physical environment, and ontography, which deals with the environed organism. This concept was adopted by Professor Walter W. Tower of the University of Chicago in his well-known classification of geography as, (1) *physiography*, subdivided into geoplanetology, meteorology, oceanography, and the physiography of the lands, and (2) *ontography* divided, according to the kinds of living things, into phytogeography, (plant geography), zoögeography (animal geography), and anthropogeography (human geography).

An important objection to this classification, however, is that the first main division, namely physiography, is not geography at all according to the modern definition, being, as stated above, a branch of geology. The same thing could be said of Professor Tower's four subdivisions of physiography. They are all not only natural sciences, but nonbiological sciences, whereas, according to his own definition, geography is concerned with life. It seemed that the divisions of the subject ought to be defined in the terms of the subject itself.

Nevertheless, this new biogeographic phase of the subject was quite a step in advance. It made geography the point of contact between the natural sciences and the social sciences, enabling this study to gather up the results of such natural sciences as geology, meteorology, botany, and zoölogy, and to offer them as raw material for workers in social sciences, that is, the historians, the sociologists, the economists, and the political scientists.

The modern or social stage of geography.—More recently, however, the tendency among geographers has been to emphasize the social or humanistic aspects of geography. Whereas, thirty years ago many workers in the field sought by various means to exclude the human element from geography, as was the case in the physiographic phase of its development, nowadays the pendulum seems to be swinging over to the point of view that, after all, "The proper study of mankind is man." Thus, Professor Harlan H. Barrows, chairman of the Department of Geography at the University of Chicago, in his presidential address of 1922 to the Association of American Geographers, presented a powerful argument for "Geography as Human Ecology." This left the physiography of Davis and the phytogeography of Tower to the natural scientists, and defined geography "as dealing solely with the mutual relations between man and his natural environment." Not all American geographers were then willing to go that far, but modern developments in geography indicate that Professor Barrows had read the signs of the times aright.

Modern Geography a Science of Relationships.

Influence of the "Origin of Species."—It may be seen then that most of that which is distinctively modern in geography has developed within a period of little more than half a century. In fact, it has been chiefly since the appearance of Charles Darwin's "Origin of Species" in 1859. Darwin, in showing that there is a delicately adjusted balance between organic life and its surroundings, taken in its widest sense, gave a new importance and impetus to the study of interrelationships.

Thus he directly did geography an enormous service in the addition of a unifying and coördinating principle, for modern geography is a science of interrelationships. Relationship, in fact, is a fundamental principle of geography. This principle not only probably prevented geography from being swamped by the enormous increase in the number of facts known in recent years, which would doubtless have proved fatal to the old sailor geography; but it also raised the subject to the level of a science.

Definition and Main Divisions of Geography.

The basis of classification.—Then, too, this principle of relationship gives the logical basis for the classification of the subject. Since geography is a science of relationships, it may be said to divide itself naturally into two main parts. If the subject is to deal with a relationship, there must be at least two things, or groups of things, between which the relationship exists.

If this relationship is to be geographic, the two sets of things related are: (1) the various environmental factors, considered from the point of view of their geographic influences; and (2) the living beings and their activities, considered in the light of their adaptations to the environmental factors, and the way in which they modify or make use of these elements in their environment. Logically, then, the divisions of geography consist of two main parts, corresponding to these two sets of related things.

Before considering just what may be included in these two geographically related sets of factors, it should be stated that in its present stage, *geography may be defined as the science which studies the reciprocal relations between man and his environment.*

Accordingly, the two main divisions of geography are: *first,* physical geography, and *second,* social geography. Both of these, being geography, must deal with this essential geographic function, namely, the relation between man and his environment. But they look at the subject from opposite sides of the equation. Physical geography treats the relationship from the side of the environment, whereas social geography examines it from the point of view of man and his activities, that is, the social aspect.

The term " social " is here used in its usual meaning, as when we speak of the social sciences. Derived from the Latin, *socius,* meaning " companion " or " associate," the adjective " social " seems preferable to the term " human," as applied to geography; because in this field of study, human beings are considered, not as individuals, but rather in groups, that is, in numbers, in relation to the earth of which they form an integral part. A further reason for preferring the term " social " here is that both physical and social geography are in a sense human geography, since they both deal with the essential geographic function, namely, the relation between man and his environment, the difference being largely that of emphasis on opposite ends of the relationship.

The New Geography in the Social Stage.

Modern views.—That we have to-day passed from the biogeographic phase to the human or *social stage of geography* is evidenced by the writings of an increasing number of geographers. H. R. Mill, in the " Realm of Nature " says: " Geography treats of the earth in its relation to man." More recently, Dr. Isaiah Bowman, Director of the American Geographical Society, in " The Andes of Southern Peru," remarks: " It is peculiarly the province of geography to study the present distribution and character of men in relation to their surroundings." Miss Marion Newbigin, editor of the *Scottish Geographical Magazine,* in " Man and His Conquest of Nature," asserts of geography that " its essential problem is to discover why man thrives more at certain parts of the globe than at others." Dr. Albert P. Brigham, professor emeritus of geology at Colgate University, declared in 1929 that " Geography deals with man, in the place where the Creator has put him." Dr. Charles L. Robbins, in " The School as a Social Institution " writes: " In Geography the earth is to be studied not merely as one of the planets exemplifying certain natural laws, but rather as the science of the struggle for human progress. . . . The physical interpretation of Man and Nature is giving way to a human, that is, a social treatment of both." And the late Professor Lionel W. Lyde, the great English geographer, in "The Continent of Europe," summed it up thus: "To most of us Geography seems to have neither meaning nor value apart from Man."

Man and Environment.

The geographic relationship.—Instead, then, of drawing the line of geographic relationships between the *inorganic environment* and the *environed organisms* (plants, animals, and man), as was done in the biogeographic phase of geography, modern geographers place plants and animals among the physical factors of the environment and consider only man, or society, as the environed organism.

Other sciences and environment.—Moreover, geography is not the only science concerned with relations between environment and life. Both botany and zoölogy deal in part with adaptations of life to environment. The botanist studies the relation between plants and their physical environment, for example, in plant ecology; and the zoölogist studies animal ecology in the same way. So, also, do the paleontologists have something to tell us about the adaptations of life forms in their vertical distribution in the geological scale, as shown by the fossil remains of former living things in the ancient rock strata of different geological ages.

No true conception of the fundamentals of organic adaptation can be complete without the sciences of botany, zoölogy, and paleontology, as well as geography. Consequently, the tendency of the modern geographer is to leave to those natural sciences the explanation of the relations between at least the wild plants or animals and their environments, and to content himself with the environmental relationships of man and his affairs.

Man and nature.—Logic, also, warrants this position. For, while it is true that man is subject to the same natural laws as plants and animals, yet on account of his intelligence, his potentiality of adaptability is so far in excess of that of any other organism that man seems to stand apart as, in a sense, the culmination of the evolutionary process.

Even considering man as a mere animal, we may note two outstanding characteristics that set him apart from other animals: (1) a distribution over all sorts of natural environments far greater than that of any other animal; (2) a homogeneity which prevents his classification into distinct species or genera, such as we find in other animals. Thus, although he has adapted himself to a great diversity of environment, yet man presents such a similarity of structure in every race or stock that only subspecies, or varieties, are recognized, and not all his classifiers agree as to these. In the case of the lower animals, on the other hand, there are a great many species with a corresponding variety of structures.

Then, too, in the case of man, geographers have to consider culture or civilization, and that is a phenomenon which does not exist in the field of the sciences devoted to the environmental adaptations of wild plants and undomesticated animals.

While man is thus in a class by himself, so to speak, yet modern science would not treat man and nature as opposing forces. Man is, after all, a part of nature and thrives best when his activities are in harmony with his natural environment. The influence of environment, however, is a very complex affair. The numerous environmental factors do not act singly, but together. Consequently, man's environment may be considered the sum total, or perhaps better, the resultant of all the external conditions which relate to him. We can hope to understand and interpret the nature of this complex of conditions only by analyzing the environment into its several components, and noting the relation of each to man, his distribution and his activities. It is hardly to be expected that any other science would do all this. So it naturally follows that it is part of the business of the geographer to do it.

The Place of Physical Geography.

Geography viewed from the environmental side.—From the foregoing analysis of man's place in nature it may be seen that the first main division of geography logically is concerned with the depicting and analyzing of the various environmental factors from the point of view of their importance as the physical basis of society. This, then, is the field of physical geography. It is a fundamental part of geography and basic to any scientific study of the subject. It is distinguished from physiography or geomorphology in that it includes not only the physiographic and climatic features, but also the biological factors in the environment of man, and goes on to point out in each case some of the reciprocal relations between these factors and man.

Various subdivisions.—Physical geography, having to do with the natural environment as the physical basis of society, naturally subdivides into branches, each one of which deals with the geographical relations to man of some one of the various elements in the environmental complex. For the present purpose these elements may be given as location (or position), climate, land, water, plants, and animals. Corresponding to these environmental factors we thus have locational geography or mathematical geography, geography of the atmosphere, geography of the land, geography of water, geography of plants, and the geography of animals.

Each of these may be further subdivided according to the degree of specialization desired, as, for example, under water special study may be made of oceans and seas, rivers and lakes, or underground waters. But in every case, if it is to be a geographical study, there should be some attention given to its relation to human life or activity.

Relation to natural science.—Physical geography is thus seen to partake somewhat of the nature of a natural science, and indeed it draws much of its material from the various natural sciences, such as physiography, botany, zoölogy, and meteorology. It differs from them, however, in that, while it uses freely the facts established by these collateral sciences, its function is that of a central unifying science, which handles its material from its own standpoint, that of their relation to human affairs. In these respects, physical geography is distinguished from physiography or meteorology, for example.

Social Geography.

Geography from the point of view of man and his activities.—The second main division of this science, namely, social geography, differs from physical geography chiefly in respect to the classification of its subdivisions and to its greater emphasis on the human side of the fundamental geographic relationships, namely, the relationship between man and his environment. Whereas physical geography is subdivided according to the various environmental factors, social geography, having to do with the environmental aspects of man and his affairs, should naturally be classified on the basis of man, his distribution, and his social activities.

Subdivision.—First, then, there is man and his distribution. Accordingly, since there are racial divisions of men, and also divisions on the basis of language and religion, we have among the subdivisions of social geography, not only racial geography, but also linguistic geography and religious geography. The subject matter of this includes not merely the distribution of man in each division, but also the ways in which the various geographic factors involved influence races, languages, and religions, respectively.

Next, corresponding to man's leading social activities, such as the ways in which he makes his living (economic activities), or his political and military activities, we find such branches of social geography as economic, political, and military geography, each one of which treats of the relations between environment and the social activity corresponding to that branch of geography. Historical geography also comes under social geography, but it is not exactly coördinate with the above subdivisions, as it may be studied with respect to any or all of them when they are considered in their time relations. To the foregoing should be added the geography of civilization, in which study is made of the geographic aspects of man's progress in general.

Each of these may be further subdivided on the same basis of man's distribution and activities. For example, under economic geography would come such subdivisions as agricultural and commercial geography, each dealing with the corresponding economic activity in its relation to environment. The essential thing in all social geography is that it is man, his distribution, or his activities studied in relation to environment.

Relation of Geography to Other Social Sciences.

Social sciences all deal with man.—Social geography is thus seen to be closely related to various other social sciences, for they all deal with man, or rather, with groups of men. When Charles Darwin in 1859 published his "Origin of Species," making the doctrine of evolution common property, he set in motion a force which stimulated and changed the course of thought in every science, in every line of intellectual effort. The resulting stimulus to research in every direction, guided largely by the desire to discover the interrelations of phenomena, has caused a breaking-down of the old barriers between the sciences.

This may be seen in the case of many of the social sciences. Thus sociology, seeking an understanding of the social life of man, gets help from history, geography, biology, psychology, and anthropology. The historian draws aid from evolutionary biology, cultural anthropology, psychology, sociology, and geography. The same thing may be said of economics, political science, jurisprudence, and so on. This is as it should be, for all the social sciences deal with essentially the same material, namely man, or rather numbers of men, that is, society.

Geography a social science.—The thing which gives a science its distinctive mark as a science is not the field of facts treated, but the aim, the course of reasoning, the purpose for which the facts are treated, the point of view as determined by the central problem under investigation. Thus sociology, economics, and political science are all social sciences, because they are concerned with society; but they are differentiated in this respect: that, while sociology deals with the general laws of social life and structure as a whole, the others may deal with specific laws which apply to particular aspects of society. So, also, geography is essentially a social science because in its modern development it deals with man, his distribution, and his activities; but it is distinguished from the other social sciences in respect to its purpose, which is to study man or society in its environmental aspects, that is, in its relation to its environment.

Social geography a coördinating science.—As social psychology, which uses psychological concepts to explain the life of individuals in groups, or of individuals as influenced by other people, has the function of connecting psychology and the social sciences; so social geography has an important part to play in considering the relation of the various other social sciences to geographic environment. Just as the social sciences, dealing as they do with man in particular situations, can not escape the biological and psychological nature of their material; so, since all human activities must take place somewhere with some surroundings, these same social sciences are bound to have some sort of environmental relationships. Herein lies the importance to them of social geography. Its particular function is the study of the environmental problems, whose solution may help to answer some of the questions that now perplex various other social sciences.

Relationship of society to its environment being the keynote, the distinctive problem of social geography, this science, then, may be considered a connecting link between the social sciences generally; for it cultivates as its own particular field, ground, some parts of which at least are of considerable importance to each of the other social sciences. It is this fact, widely recognized in the curricula of the public schools, and becoming more and more generally recognized in the colleges and universities, which makes social geography a good introduction to, and a logical coördinating science for, the other social sciences.

Other social sciences and geography.—Space forbids an extended discussion of the relation between geography and other social sciences, but a few will illustrate. Economics, for example, being concerned with ways of making a living, studies man in two sets of relations. "It has to do," as Professor Frank A. Fetter, head of the department of economics at Princeton, says, "almost constantly with the material environment as well as with the social environment in which men live." Thus its field seems to overlap that of geography. It is the point of view, however, that is different. A leading economist, Professor Herbert A. Davenport of Cornell University, clearly states it thus: "It is, in fact, the value problem, or more specifically and more accurately for present society,—the problem of market price, that is the central and unifying problem of present-day economics." One branch of social geography, economic geography, deals with material which must always be of interest to students of economics.

The sociologist, too, interested in theories of social causation, must take account of the rôle of geographic factors, as well as that of the biological, psychological, and cultural factors in the evolution of society. Consequently, the results of geographical investigation must in part always have a place in sociology, if the latter is to remain the general science of society.

Even cultural anthropology does not consider that culture can be explained by psychology alone, but holds that local cultures must be studied in their historico-geographical settings. Hence, modern anthropology with its routes of "diffusion," or its "culture areas" and its "marginal areas," must, like the old classical anthropology, bear a close relation to the field of the social geographer. So also, political science is related to political geography, and history to historical geography. Thus it becomes apparent that all the social sciences, since they all have an environmental aspect have, or should have, some interest in the questions to be investigated by social geography.

Modern geography not deterministic.—While modern geography, however, is seeking the solution to environmental problems, it does not claim to have found them all yet. It is only beginning the analysis of the data, which every day is becoming more abundant and more available. Neither does the social geographer attempt to maintain an *environmental determinism,* that is, a theory that environment accounts for all man's activities and accomplishments. Many factors must be considered in any account or explanation of human associations, activities, and institutions. Some of them, however, are geographic. It is with these that social geography is concerned.

While the coördinating principle of modern social geography is relationship, another equally important is the principle of *change.* This means that nothing in nature or in society is fixed and unchanging. All is in continual transformation. Thus the surface of the earth is continually being modified by internal and external forces. Climates have changed. Human groups, in size, distribution, character, and culture, must be studied in evolution. Consequently, the relationships between man and environment are always different at different times, and in different stages of human culture.

Social progress must be considered the *joint product* of man and nature. And man is the active agent in the coöperation. As he progresses, culture becomes a third factor in the partnership. Nevertheless, what man accomplishes or produces depends not only on what he wishes and can do, but also in part, at least, on what he has to do with.

THE CLASSIFICATION OF GEOGRAPHY

Main Divisions	Subdivisions	The Two Groups of Factors Geographically Related
		I. *Man's Distribution and Activities*
B. Social Geog.	1. Racial Geography:	Types, races and stocks of people.
	2. Linguistic Geography:	Languages of mankind.
	3. Religious Geography:	Religions of the world.
	4. Economic Geography:	Ways of making a living.
	5. Political Geography:	Nations, states, cities, and other political activities.
	6. Military Geography:	Wars and military operations.
	7. Historical Geography:	Events of history.
	8. Geography of Civilization:	Health, Energy, Progress.
Geography	*is the study of the* . . . . →	↑ Reciprocal Relations Between ↓
		II. *Environmental Factors*[1]
A. Physical Geog.	1. Mathematical Geog.:	Location (size, form, distance, etc.).
	2. Geography of Climate:	Weather and climate (atmosphere).
	3. Geog. of the Land:	Topography, soils, minerals etc.
	4. Geog. of Water:	Oceans, seas, and inland waters.
	5. Plant Geography:	Plant life.
	6. Animal Geography:	Animal life.

Each of the subdivisions listed above may be further divided, as it is desired to make special studies of the geographic relationships of the factors involved, as for example: B (4) Economic Geography may be divided according to the environmental influences on each of the ways of making a living; and A (3), Geography of the Land may be divided on the basis of the geographical relations of each of the aspects of the land, thus:

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[1] In social geography, to any individual or group of people another group or the works of man may constitute an environmental factor in addition to those listed. Thus, Dr. S. S. Visher, professor of geography at the University of Indiana, in the *Journal of Geography* for September, 1928, calls attention to "the broader definition of environment which is coming into use . . . namely, that environment includes not only the physical environment but also the biologic and social environment."

- B. (4) Economic Geography
  - Pastoral Geography.
  - Agricultural Geography.
  - Industrial Geography.
  - Commercial Geography.
  - Geography of Mining.
  - Traffic Geography.
  - Financial Geography.

- A. (3) Geography of the Land
  - Geography of Mountains and Valleys.
  - Geography of Plains and Plateaus.
  - Geography of Soils.
  - Geography of Minerals.

So, also, any or all of the divisions and subdivisions of geography may be studied with reference to any particular region, small or large, and then it is known as *Regional Geography*. These regions may be cities, counties, states, nations, continents, or the natural or economic areas within a continent; and the geographic studies of such are termed, for example, the Geography of the Columbus Trading Area, the Geography of the Great Plains, the Geography of the Corn Belt, the Geography of Pittsburgh, or the Geography of Europe.

CHAPTER II

MAN'S DISTRIBUTION AND ACTIVITIES

Some Aspects of Population.

People live in groups.—Since the central theme of modern geography is man, or society, studied in relation to environment, it is obvious that the student should take note of at least some of the main facts about man, his distribution, and his activities, before he can hope successfully to attempt correlations with the environment.

One of the primary facts to be observed is that men normally do not live in isolation, whether savage or civilized. The wandering hordes of native Blackfellows in the desert of Central Australia, of Bushmen in tropical Africa, or of Highlanders in arctic Greenland, though small and variable in numbers, are nevertheless groups, each composed of several families. So it is in civilized countries, whether in city or country, for always we see the people living in social units —families, communities, and nations. This tendency to live in association with many others seems to be on the increase, too. For example, in the United States now, more than half the people live in cities or towns of over 2500 population. This the United States Census calls the *urban* population; those living in smaller towns and in the country are classed as *rural*. In Europe, as in the United States, the percentage of urban population has for many years been on the increase. Such conditions give rise to many problems of interest to social geographers, as well as to other students of social science.

Density of population.—Another interesting fact about population is its very uneven distribution throughout the earth. This gives rise to a very fundamental geographic relationship, namely, the ratio between population numbers and land area. The concept is expressed as density of population, which means the number of people of a country or region divided by its number of units of land area, the quotient being expressed as so many persons per square mile, or per acre, for example. This resulting number is of course only an average, and does not by any means indicate that every square mile in the country has that many people. The density of population, however, is a very useful figure, and permits of many comparisons between countries and regions. If the figure is high for a country, its population is said to be dense; if it is low, the population is sparse.

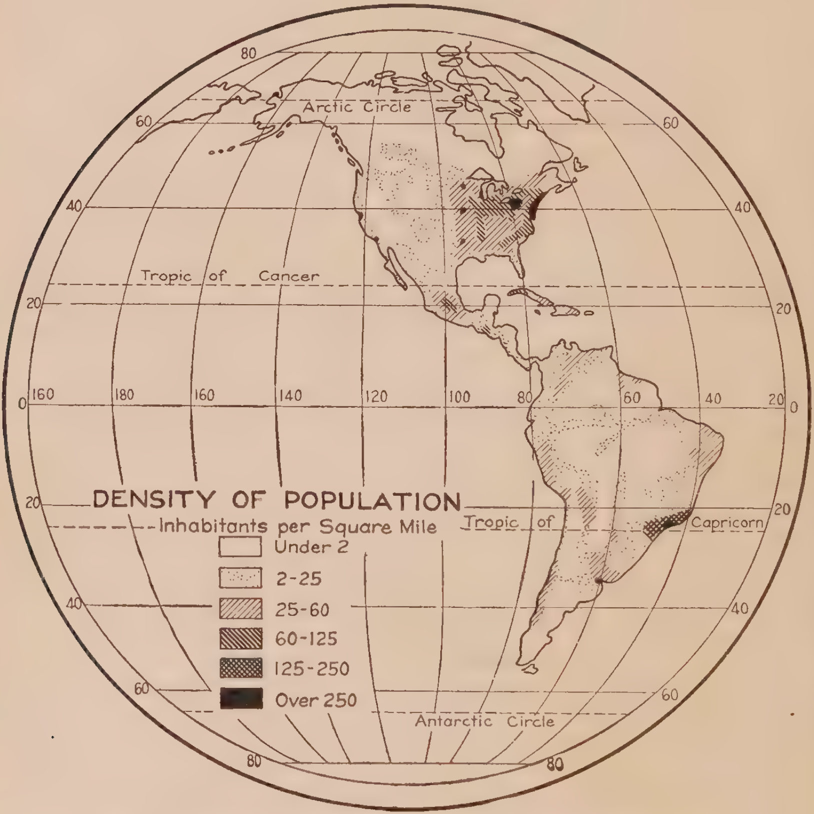


Fig. 1.—Density of Population of the Western Hemisphere.

The map in Figs. 1 and 2, giving in six different shades the corresponding gradations from less than two people per square mile to more than 250, shows the density of population throughout the world. This not only illustrates many striking facts of geography, but suggests several important geographical problems as to why some parts of the earth are so densely populated, while others have scarcely any people at all.

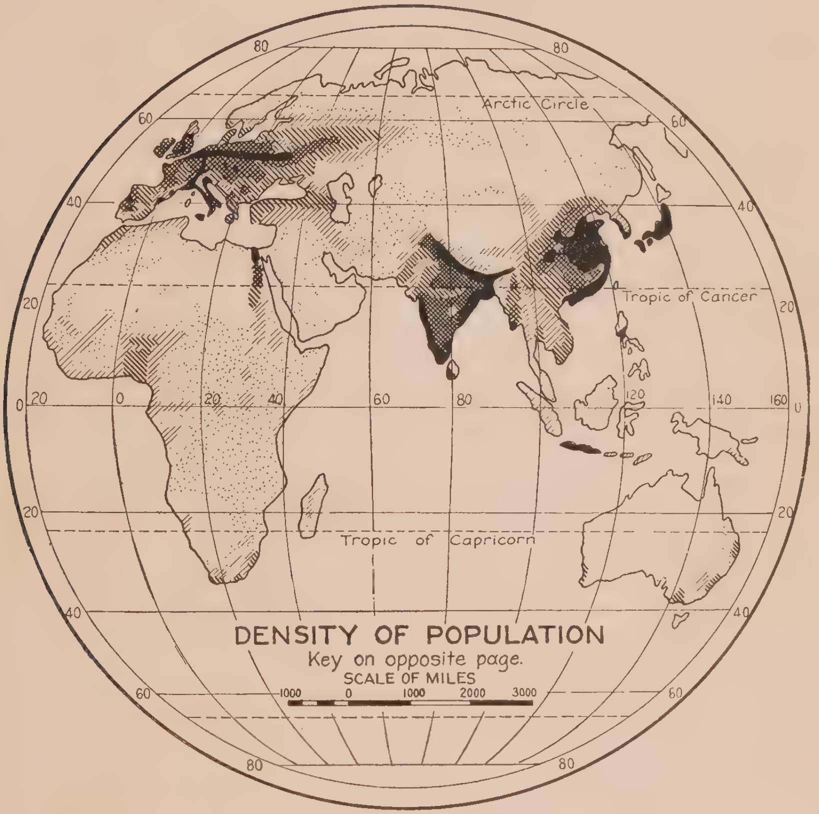


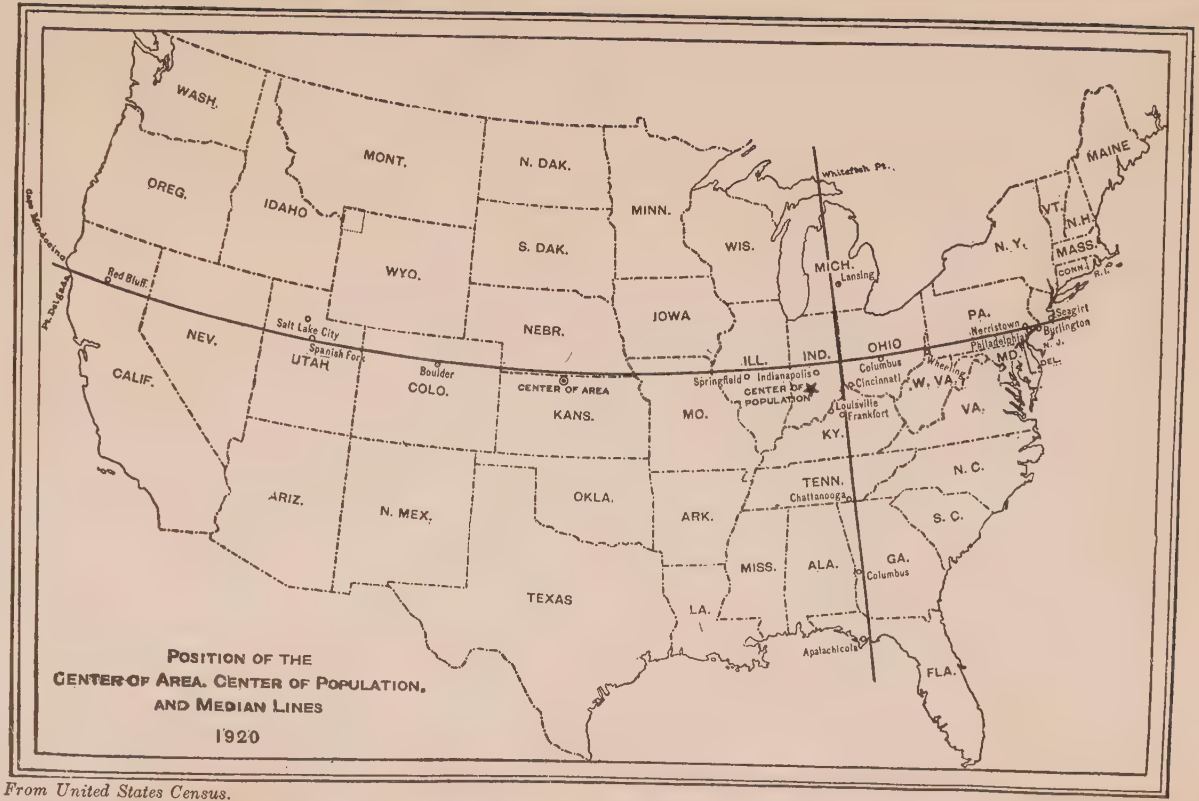
Fig. 2.—Density of Population of the Eastern Hemisphere.

Center of population.—Just as the phrase "density of population" expresses an important geographic relationship between population and land area, so the term "center of population" is used to express another geographic relationship between population numbers and their distance from two given lines. The point called the center of population (of a given area) is the intersection of a north-and-south line with an east-and-west line, such that, (1) the number of people in the area east of the north-and-south line, multiplied by their average distance from that line, just equals the number west of that line multiplied by their average distance from the line; and (2) that the number of people north of the east-and-west line, multiplied by their average distance from such line, equals the number south of the line multiplied by their average distance from this east-and-west line.

This does not mean that the number of people east of the center of population just equals the number west of it, and that the numbers north and south of the center are equal; because distance has to be considered, and a smaller number at a greater distance will balance, so to speak, a larger number at a shorter distance. That is, the center of population is a sort of " center of gravity " of the population of the area.

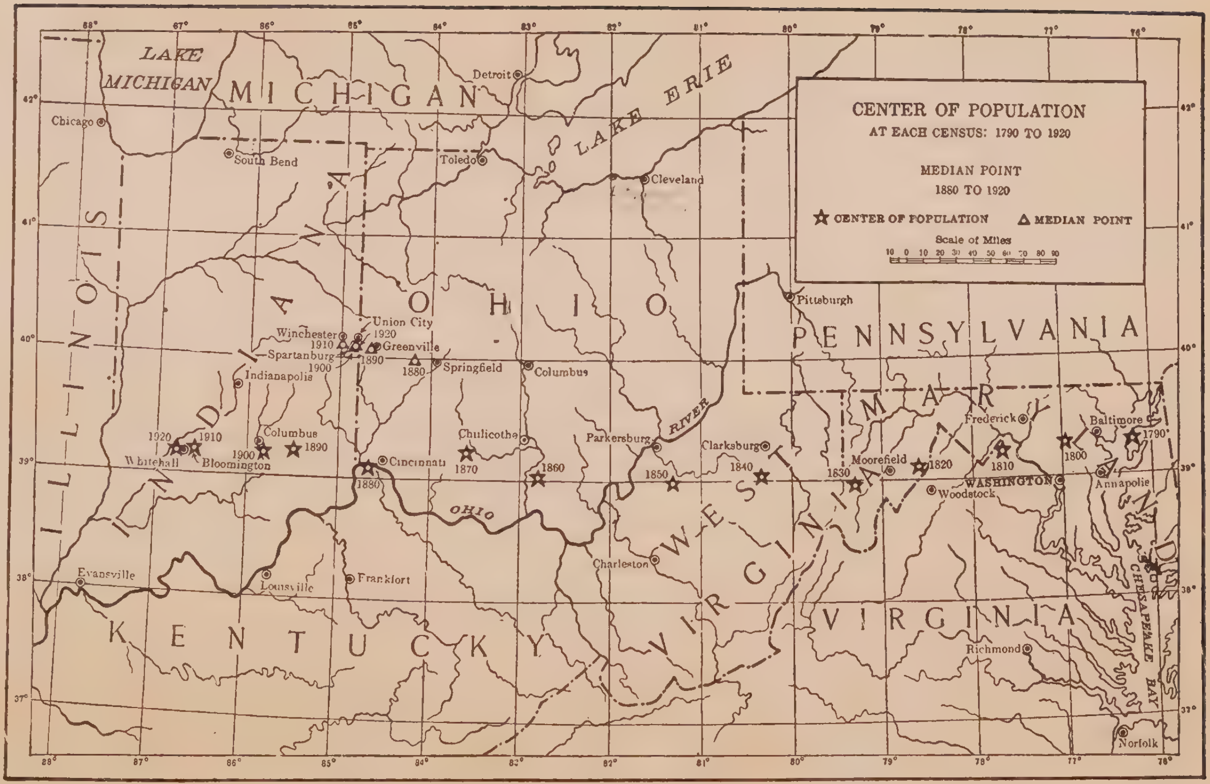
The point where a north-and-south line dividing the population equally, intersects an east-and-west line also dividing the population equally is known as *the median point,* which should not be confused with the point called the center of population. Thus the median point of the population of the United States in 1920 was near Union City, on the boundary between Ohio and Indiana, but the center of population was more than a hundred miles farther southwest near Whitehall, Indiana (see Fig. 3). As a country's population grows or shifts, of course, its center of population tends to move (see Fig. 4).

The growth of population.—Whether a country's population increases, declines, or remains stationary, depends upon the relation between four factors: the birth rate, the death rate, immigration, and emigration. Thus, if the birth rate (the number of births per thousand people in a year) is higher than the death rate (the number of deaths annually per thousand people) there will be what is called a natural increase in population. Additional increase of the country's population results if immigration (people coming into the country from another country) exceeds the emigration (people going from this country to another). But when we consider the world as a whole, obviously, the birth rate and death rate alone have



From United States Census.

Fig. 3.— The States of the United States, the Center of Area, the Center of Population in 1920, and the Median Point of the Population (where the median lines cross) on the Ohio-Indiana Boundary Line.



From the U. S. Census.

Fig. 4.—Showing the Movement of the Median Point and the Center of Population of the United States.

Note that from 1910 to 1920 the Center of Population moved Westward as usual, but that the Median Point moved back eastward.

to be considered, inasmuch as aërial transportation between the earth and Mars, or any other planet for that matter, has as yet been established only in works of fiction.

The total population of the earth at present is estimated at approximately 1,850,000,000. This is a number so large that it does not mean anything very definite to most of us. A remarkable fact about it, however, is that the number has doubled in only a little more than a century, for in 1800 there were only about 850 million people in the world. Mr. W. S. Rossiter of the United States Census Bureau calculated that in 800 years from 1000 *A. D.* to 1800 the white races alone increased from some 30 million to 210 million, and that by 1915, this number had grown to 645 million. In other words, 115 recent years showed a gain two and one-half times as great as the preceding 800 years. Or, as Professor Lescohier of the University of Wisconsin remarks: "It took mankind half a million years to produce the first 850 million, and then but a century to double the number."

This rapid growth of the world's population during the last century has caused much concern to many statesmen in different countries, and to thinking students of the subject in this country and abroad. For population growth is to-day one of the most vital problems of America, as well as of many other nations. A recognition of this among the masses of native Americans was back of the recent Ku Klux Klan movement and the present law placing greater restrictions on immigration into the United States. Their point of view is expressed in the slogan, "America for Americans." A similar slogan is heard from the opposite side of the globe in "Australia for the Whites."

The problem, while important alike to statesman and business man, to biologist and agriculturist, to economist and sociologist, is essentially geographic, for it has its crux in the question: How and where can this old earth continue to produce food enough to feed this growing population, unless the rate of growth is soon checked?

The Malthusian law.—The question was brought into prominence a hundred and thirty years ago by the writings of Thomas Robert Malthus in England, who expressed the principle that population has a tendency to outstrip the means of subsistence with the result of poverty, misery, and famine. He pointed out, by many examples from history, that time and again war, or crop failures, or pestilence, greatly reduced the population of a country, but that almost invariably the loss was rapidly made up by population growth in a single generation, up to the limit of the food supply.

On the whole, his view was rather pessimistic. As we have seen, the century since Malthus has witnessed a still more rapid increase of population. It was made possible largely by the opening-up of new agricultural lands, and by wonderful advancement in science, art, and industry, which increased production even faster than the growth of population. It is not likely that production can continue to increase at such a rate. Hence in the future, we must look for checks in population growth. In our modern society, the most effective motive limiting population is the desire to maintain and raise the standard of life. But the Malthusian law may still be said to apply. That is, in any given state of industry and science, population tends to increase faster than it is possible to raise the general plane of living.

The standard of living.—The expression, "standard of living," is complex in thought, but may be said to mean the measure of necessities, comforts, and luxuries which one considers indispensable for himself and his children, and to secure which one will make great sacrifices. Of course, this standard differs with individuals and countries. In many countries, as, for example, in India, it is so low as to mean a bare existence for many; and misery, starvation, and death lurk at the door. The standard of living in the United States, though differing greatly in different classes, is yet on the whole, the highest in the world. Efforts to improve the quality of the population rather than to increase the numbers are therefore timely, regardless of the extent of our great open spaces, the abundance of our natural resources, and the prospects of increased food production through machinery and science. The important problem is—what is the best number of people, or *optimum* population, for the proper utilization of our resources so as to return the highest average condition of well-being to our people for the longest time?

The Racial Distribution of Man.

Bases of classification.—So far we have been considering man in general. It has been pointed out that one of his characteristics is that he is a social being, that is, he lives in groups. But any group of human beings of the same kind or description in a number of important respects, and dwelling together in a fairly well-defined geographical area may be called *a population.* The foundation of all scientific knowledge is classification, and that means the putting-together in thought the things that are really alike. So, to classify the human population means a more or less systematic arrangement into groups, according to the important respects in which the numbers are alike.

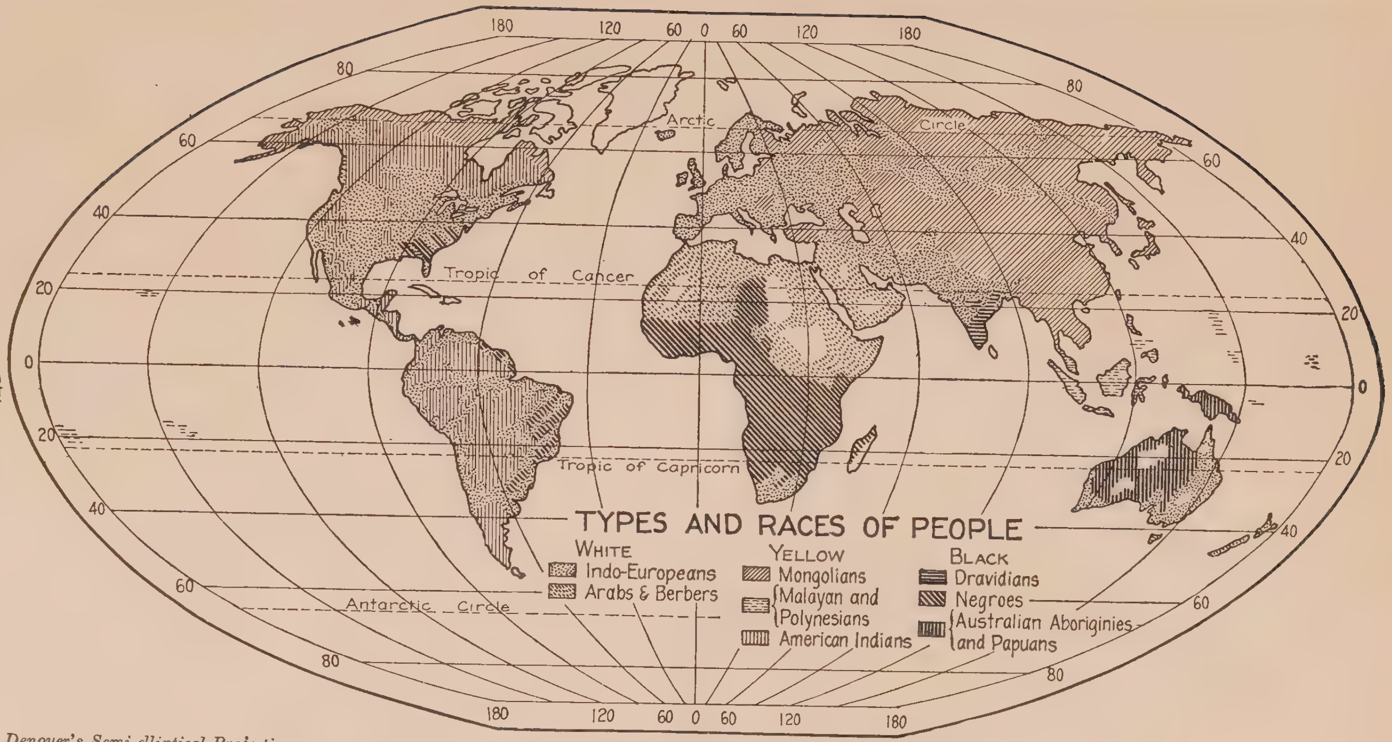
Now, while man as an animal forms in zoölogical terms only a single species (*homo sapiens*—the wise), yet he is subject to classification in as many other ways as there are natural groups of relationships resulting from his physical, economic, political, and spiritual characteristics. So there may be divisions into races, families, towns, nations, religious organizations, and so forth—the study of which forms the basis of various sciences more or less closely related. Thus the study of mankind in the widest sense is known as anthropology (*anthropos*, man, and *logos*, a discourse), and the special science relating to the races of man is ethnology (*ethnos*, a people, and *logos*), while the scientific study of the social relations of man is sociology.

Racial divisions of mankind.—According to the anthropologists a racial classification should be based on physical characteristics. Unfortunately, however, in general usage the word "race" has come to have a rather varied meaning. Thus, we hear the expression "the human race," which obviously refers to the whole population of the earth; again, we speak of the white "race," which, of course, could mean only a part of the world's people; and finally, mention is frequently made of the Anglo-Saxon " race," which includes by no means all of the so-called " whites." It may be stated though that the term " race " should not be confused with language nor nationality. A nation may include people of different races, or people speaking different languages. So, also, a race may consist of people of different nationalities or languages. And the people speaking a given language may be composed of representatives of different races and of different nationalities.

Accepting the authority of the anthropologists, however, that a *race* is a group defined and characterized by certain physical characteristics, we still have the problem of deciding how such groups are to be recognized. On what physical characteristics shall we base the classification? Different ones have been used by various writers. Thus, color has often served as a criterion; color of the skin, of the eyes, or of the hair. The character of the hair is also used, whether it is wavy or straight, frizzly or woolly. Other physical characteristics employed are the skull shape, the facial angle, and measurements of the skeleton.

Depending upon the characteristic used as a basis, writers have differed as to the number and composition of the races of man. Thus color, one of the first characteristics to attract attention, has been used as the basis for three divisions by Bartholomew, namely, the White, Yellow, and Black types; for four divisions by Kelsey, the Black, Chocolate, Yellow, and White groups; and for five divisions by Blumenbach, who used the word Caucasians for the Whites, who, he thought, had originated in the Caucasus Mountains. The last classification with some modifications is still in general use. Almost every one of intelligence has some notion of the five races, variously designated as: (1) black, Negro, African, or Ethiopian; (2) brown, or Malay; (3) red, Amerind, or American; (4) yellow, Mongolian, or Asiatic; and (5) white, Caucasian, or European.

Such a classification has some advantages. The groups are few and, it should be noticed, they correspond to great geographical areas, as is indicated by the fact that in each case one or more geographical designations is joined to the



Denoyer's Semi-elliptical Projection.

Fig. 5.—Distribution of the Leading Types and Races of People.

adjective indicating the complexion. Other means of classification, however, have become recognized as quite as important as complexion and geographical location, and it is thought by some that no single criterion is adequate, as the conditions are too complex. So, naturally, different investigators get different groups. Some favor simplifying the problem, and divide mankind into only a few groups marked by few and broad similarities, ignoring the many differences in other details within the groups. Others, impressed by these differences in detail, enumerate more races. Thus Linnæus, Cuvier, and Giddings each listed three main groups with many subdivisions; Huxley and Leibnitz recognized four; and Arnold Guyot, six. Recently Professor Dixon, the noted anthropologist of Harvard, has divided mankind into eight fundamental types, while much earlier Agassiz placed the number at nine. Others have devised schemes involving twenty or thirty distinct races and subraces, while some recent students have claimed that one or two hundred groups must be recognized.

In view of all this array of authority, and of all the scientific thought and work that has been devoted to the subject, the poor geographer, therefore, is forced to the conclusion that the anthropologists are not yet in complete agreement on all the fundamental points. For the sake of simplicity, then, we shall consider the *major divisions of mankind* as consisting of three types, each of which has certain distinguishing characteristics, the most satisfactory for this purpose probably being the character of the hair. The three main varieties of hair in the human family are the *straight*, the *wavy*, and the *woolly*. These varieties of hair are marked by different cross-sections, woolly hair being flat, the wavy elliptical, and the straight circular, in cross-section. The three major types of mankind classified on this basis, as for example in the revised edition of "Man, Past and Present" by A. H. Keane, a famous English ethnologist, correspond to the Yellow, White, and Black types; and when subdivided into races, they may be seen in their geographical distribution on the map in Fig. 5.

The races of western Europe.—About the middle of the nineteenth century, European scholars began to realize that the shape of the skull constituted a reliable and enduring basis for classifying mankind. Professor Ripley of Harvard makes this one of the bases of classification in his book "The Races of Europe." As is generally known, the human head is nearly always longer than broad, so the ratio between the width and the length of the skull is taken as the *cephalic index.* Taking the length as 100 per cent, this ratio may be expressed as a percentage. If this index, upon dividing the width by the length, is under 75 per cent, the head is called *dolichocephalic,* or long-headed; if the index is above 80 per cent the head is *brachycephalic,* broad or round-headed. A third class between the other two is called *mesocephalic*—when the cephalic index is between 75 and 80.

On this basis chiefly, the white people of western Europe are divided into three races: (1) the Mediterranean race in the south near the Mediterranean Sea, long-headed, with dark eyes, dark hair, and dark complexions, but short of stature; (2) the Nordics in the north around the North and Baltic Seas, tall dolichocephalic blonds, mostly with blue eyes; and (3) the Central or Alpine race, a brachycephalic race, mostly brunets with dark or gray eyes, and brown or chestnut hair, and of rather stocky build. Each of these races includes a number of peoples, stocks, or nations. Thus the Mediterraneans include Iberians, Corsicans, Italians, and so forth; the Alpines include many French, the South Germans, the Swiss, the Austrians, the Yugo-Slavs, most Poles and Russians, and so forth; and the Nordics embrace the Scandinavians, Northwest Germans, Dutch, Scotch, some Irish, most English, and so forth.

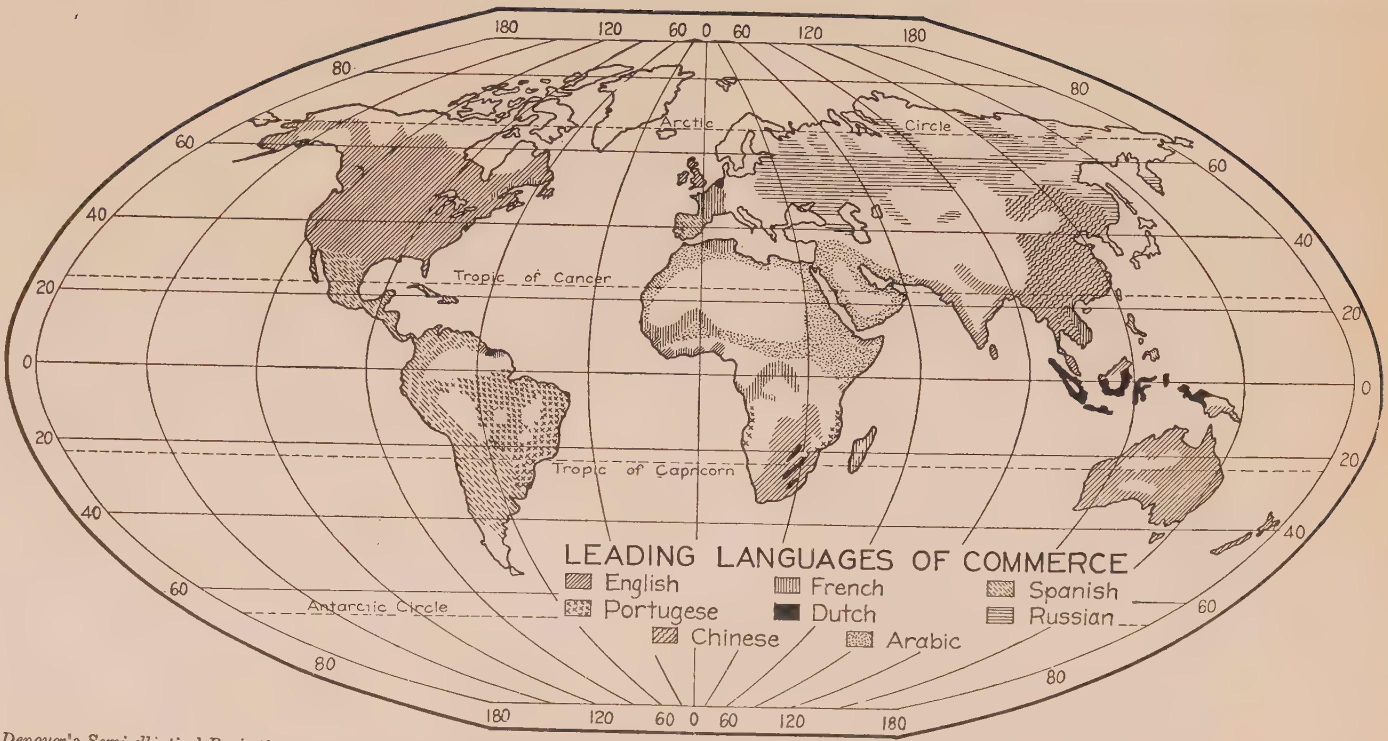
Other Forms of the Distribution of Mankind.

The great languages of the world.—When primitive man wished to communicate with his fellows, he probably expressed himself by grimaces, vocal sounds, and gestures. Each of these methods is still employed somewhat, but in the evolution of language it was the combination of voice and ear that survived as the most economical method, and the one most flexible in its capacity for variation and superior perceptibility. It was the attempt to communicate thought that gave birth to language, and undoubtedly language always had an important part in the development of human associations, in the formation of the various social groups which mark the distribution of mankind to-day.

So we find different sounds, words, and languages peculiar to particular communities, tribes, nations, or races; as, for example, the French language, the German language, and so on. The various languages may be grouped into families, as, for example, the Semitic family, including, as its two most important members, the Hebrew and the Arabic; and, on the other hand, they often present local varieties called dialects. Thus probably each language of the barbarous tribes of Asia, Africa, and the Pacific islands, has as many dialects as the people has tribes. This makes it a hard matter to estimate the number of people using each language, or even to designate the number of languages now in use.

Languages are classified according to two general principles: (1) morphologically, according to the structure of the language and the manner in which the sounds are formed, or combined; (2) genealogically, according to their connection or relationship as to origin. An example under the first class is the Chinese, which is a so-called isolating language, consisting entirely of monosyllabic, unchanging roots; while a good example of a family of languages classified according to a community of origin is the Aryan or Indo-European, which includes seven or more great groups or branches, two of which are the Teutonic and the Celtic. Each of these many groups is further subdivided. Thus the Celtic branch includes the Highland Scotch, the Welsh, the Irish, and so forth.

The French language was at one time the language of the courts of Europe, and is yet frequently considered essential to a finished education. The Chinese language with its many dialects is spoken by the greatest number of people (370,000,000); English, spoken by some 160 million people comes next, and, territorially considered, exceeds all the rest. It is the language of the British Isles, of the United States, of Canada,



Denoyer's Semi-elliptical Projection.

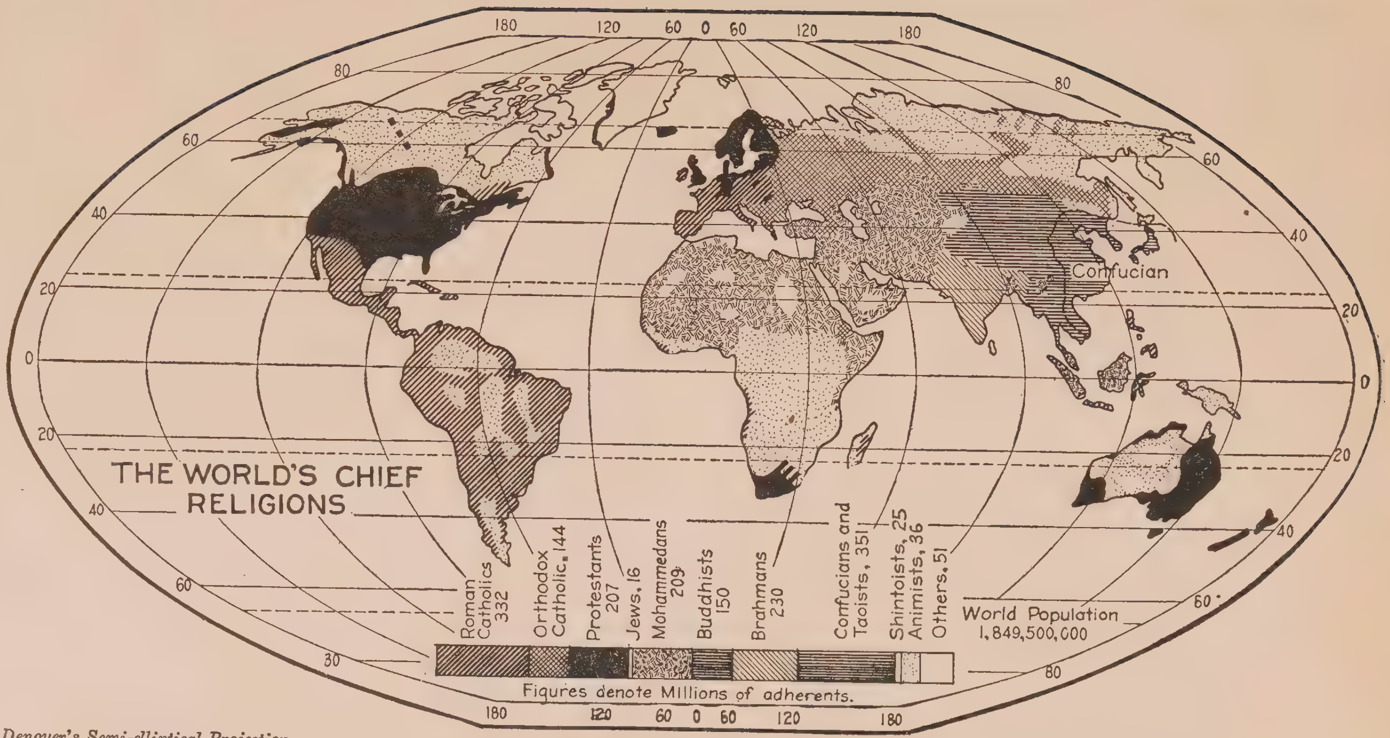
Fig. 6.—Distribution of the Leading Languages of Commerce.

South Africa, Australia, New Zealand, and of other divisions and islands both of the British Empire and of the United States. Most of the other languages, except Spanish, are territorially limited as to expansion. Spanish still has much room to spread in South America, but English has greater space for expansion and, moreover, its employment by maritime powers will tend to make it the language of diplomacy as well as of commerce.

The leading languages of commerce to-day (see Fig. 6) are the English (spoken by 160,000,000 people), the German (100,000,000), Russian (100,000,000), French (70,000,000), Spanish (50,000,000), Italian (50,000,000), Portuguese (25,000,000), the Dutch, the Chinese, and the Arabic.

Religions of mankind.—Another great factor in the social development of mankind, the importance of which has been recognized by nearly all the students of the subject, is religion. Its importance, for example, has been particularly marked in tribal organization and race differentiation. Religion is practically universal. That is, in all ages and in all places man seems to have had some notion of religion. Throughout the entire history of mankind it has been an ever present factor, a force that has had to be taken into account everywhere. In many cases it has served to differentiate groups and races, but, on the other hand, it is also just as powerful a force tending to unite people. In many cases, it has been the controlling influence holding together families, tribes, groups, and nations. Religion is a spiritual interpretation of the universe.

A religion may be defined as a group of religious phenomena, of religious beliefs, practices, and institutions, so closely connected with one another as to be therefore differentiated from those of any other religion. Each religion, of course, has had a history, and its formation, rise, spread, and various transformations can be historically traced. But when it comes to classifying religions, as in the case of languages and races, some difficulties are encountered. Thus, we might class them as true and false, or natural and revealed, or religions of savage and of civilized peoples, or in various other ways.



Denoyer's Semi-elliptical Projection.

Fig. 7.—Predominant Religions by Regions.

Probably the most generally recognized *classification*, however, is that of Christians, Jews, Mohammedans, Hindus, Brahmans, Buddhists, Confucians, Shintoists, Taoists, and Heathen. The Christians consist of three great groups, Protestants, Roman Catholics, and Eastern or Orthodox Catholics, while most of the Heathen seem to be Animists. In animism or nature-worship, the various phenomena and forces of nature are supposed to be in activity in response to the will of various spirits. Thus we see in it a geographical relationship between man and nature, an instance of religious geography. The geographical distribution of these different religions and the number of their adherents are shown in Fig. 7.

Man's Activities.

Nature of activities.—By activities is here meant simply the things that people do. Everybody, of course, does something. Even an infant breathes, eats, and cries, and in each of these activities there may be found influences of its environment. School children play, fight, study, learn, recite, and often engage in argument. And much of their advancement, if any, is related to their environment. Savages hunt, fish, dance, and engage in religious ceremonials and tribal warfare. Their environment usually has a most powerful influence upon their progress or decline, their activities, their very existence. Civilized man engages in farming, mining, manufacturing, and commerce, attends fairs, movies, automobile races, and prize fights, and develops art, science, politics, education, and religious institutions. He is not so directly dependent on nature as the savage; yet in all his activities there may be found some connection with his environment. All his production and all his progress will be found to be the resultant, directly or indirectly, of the *two primary factors*, man and nature. Civilized man has merely learned better how to utilize, take advantage of, or control nature.

Classes of social activities.—Man, as we have seen, lives in groups. Civilization, in fact, is unthinkable, if not thought of in terms of numbers and contact between numbers of people. Consequently, by far the greater number of man's activities are, in one way or another, social activities. Now, social activities may be considered the vital power in human society. Practically all social forms and institutions have been developed from the activities of people. Thus laws and rules of action, whether in business or in recreation, are usually not established until a need for them is recognized on account of the actions of individuals or groups. These social activities originate mostly in the effort to satisfy human desires of one kind or another, and from these efforts various social organizations and institutions result.

Consequently, these varied efforts to gratify human wants constitute a natural basis for the classification of human activities. First may be mentioned man's efforts to satisfy his feeling of hunger, his endeavors to avoid the undesirable feeling of cold, or other efforts to gratify emotions arising from some one of his five senses. But these senses, as seeing, hearing, smelling, and so forth, are the means by which man comes in contact with, or gets knowledge of, the outside world. In other words, they bring him into conscious relation with his environment. Hence, from the very first, man's activities are subject to *environmental influences,* and are directed toward the *utilization of his environment.* These two things constitute the essence of the geographic relationship. Man's feelings and desires may be not only gratified by his environment, but frequently restrained by that environment. His surroundings, either physical conditions or fellow men, may make it impossible or undesirable for him to indulge in unrestrained gratification of his bodily wants. So we may say that probably the first of man's social activities are those arising in connection with feeling or the restraint of feeling.

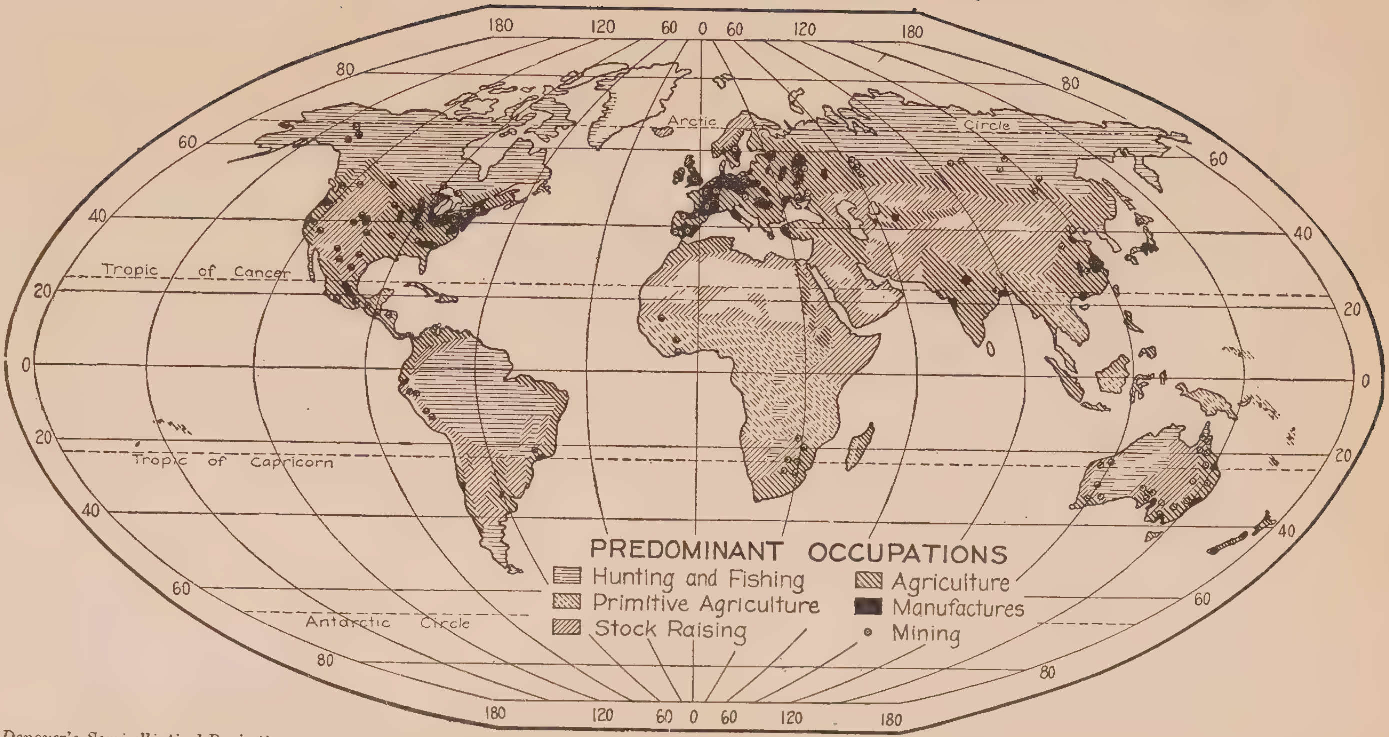
As the individual gains knowledge of the world of things and men about him through what the psychologists call responses to stimuli through his organs of sense, he gets an *appreciation* of his surroundings. This is aided by *imitation.* For example, the child sees something or somebody that arouses his admiration and curiosity, so he tries to copy and thus acquires familiarity. In so doing, he develops preferences and makes a sort of *valuation.* Probably his next move is to experiment to find out what use he can make of these things and people. This activity of trying to control, adapt, or use the things about him may be called *utilization.*

Economic activities.—Most of us can not get all the things we desire. We have to compare one thing with another, and then, whether by instinct, experience, judgment, or something else, we choose the one which for us seems to have the more importance. This quality of importance, which a man attributes to a thing when it is the subject of his choice, the economist calls *value.* The collective name for things of value is *wealth.*

So we have a series of activities arising from the relations between (1) human feelings or wants, (2) the external things of value which it is thought may gratify those wants, and (3) the attempts, efforts, or work to get or utilize these things. These are the economic activities. They constitute the most fundamental of all the social activities, for they are the ways in which people make their living. The special social science which has the study of these activities as its particular field is known as *economics;* while the study of the relation of these economic activities to environment is *economic geography.*

The economic ways of making a living may be classified into primary industries, secondary industries, and personal or professional services. The *primary industries* include: (1) such extractive industries as fishing, logging, and mining, where man gets products directly from nature by the application of labor, and (2) such genetic industries as stock raising and agriculture, where man brings about the production of things like food and raw material by getting the environment (as soil, climate, and grass) to help him to "raise" or "grow" such stock or crops as cattle or wheat from stock or seed which he had to start with. It is a case of creating value by increasing the quantity of a product with the help of nature.

Secondary industries are such as take the product of a primary industry and make it more valuable by adding to it



Denoyer's Semi-elliptical Projection.

Fig. 8.—Predominant Occupations of the World by Regions.

either (1) form value, (2) time value, or (3) place value.[1] Thus manufacturing may increase the value of wheat by changing it into the *form* of flour; elevator storing may increase its value by holding it until a *time* when the market demand is greater; or transportation may increase its value by changing its *place* from Kansas to Liverpool, a great European market. A merchant may buy goods in New York in January and bring them to Columbus to sell at Easter, thus adding both place and time value. Consequently, he is engaged in productive industry. The environmental elements involved include both place and season. So even this is an instance of increased value of goods being the joint product of man and environment (see Fig. 8).

Personal and professional services include such occupations as law, medicine, teaching, preaching, dishwashing, hairbobbing, and toothpulling. Their environmental relationships are not so apparent but their importance as social activities is clear. They should contribute to the conservation of human resources, which, after all, is the most important form of natural resources.

Political activities.—The production of wealth which results from economic activities can not get very far without the establishing of some degree of law and order in the community, of some form of security or protection to life and property. People are not going to work hard to produce anything much more than their immediate needs require unless they feel some assurance that their produce will not be seized and carried off by some marauding band, and perhaps their houses and lives endangered. So we find next in importance, to economic activities and probably next in point of time, come legal or judicial activities, which are concerned with the development and application of rules of law, and the establishment of justice.

In civilized society these activities are a part of the functions of the state, a modern definition of which is " a people organized for law within a definite territory." This definition conveys the idea that a modern state includes the concepts of both land and population. Clearly, then, there is involved a geographical relationship as well as a political institution. *Political science* is the study of the state, including its origin, its organization, its functions, and its institutions. We all know that the state has to do with government. Now, the functions of government include not only lawmaking and law enforcement, which are necessary for the protection of life, property, and liberty, but many other things, such as the regulation of trade and industry, and the maintenance of highways, waterworks, sewers, post offices, and of charitable and educational institutions. All of these activities are political activities. There are also many others, such as the conventions of political parties, the location of capitals, the mapping of coastlines, and the surveying of boundary lines. A study of the environmental relationships of any of such political activities is called *political geography*. An example would be the pressure of a geographical region such as the Corn Belt in compelling a political party to adopt a plank in its platform calling for farm relief legislation. The chief political divisions of the world are shown on the map in Fig. 9. Likewise, Fig. 3 is a political map of the United States.

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[1] Some economists refer to these ways of increasing value as the adding of *utility*, (1) form utility, (2) time utility, (3) place utility, and (4) elemental or stuff utility (where the quantity of the substance is increased, as in growing wheat).

Military activities.—One of the functions of the state being that of protecting its citizens and their property, not only from lawless elements at home, but also from possible invasion or aggrandizement by a foreign power, most modern states maintain systems of national defense. Such involve the activities of the War and Navy Departments, for example. If war breaks out or is threatened, we find military activities at once assume a position of importance even in a country which may not maintain a so-called standing army. For the sake of simplicity, military activities are here considered to include those of the naval forces, and also of the aërial provisions for offense or defense, which are now being developed in many countries.

War and military operations always have involved rather important *geographic considerations*. Thus, in the Old French and Indian War between France and England for the posses-

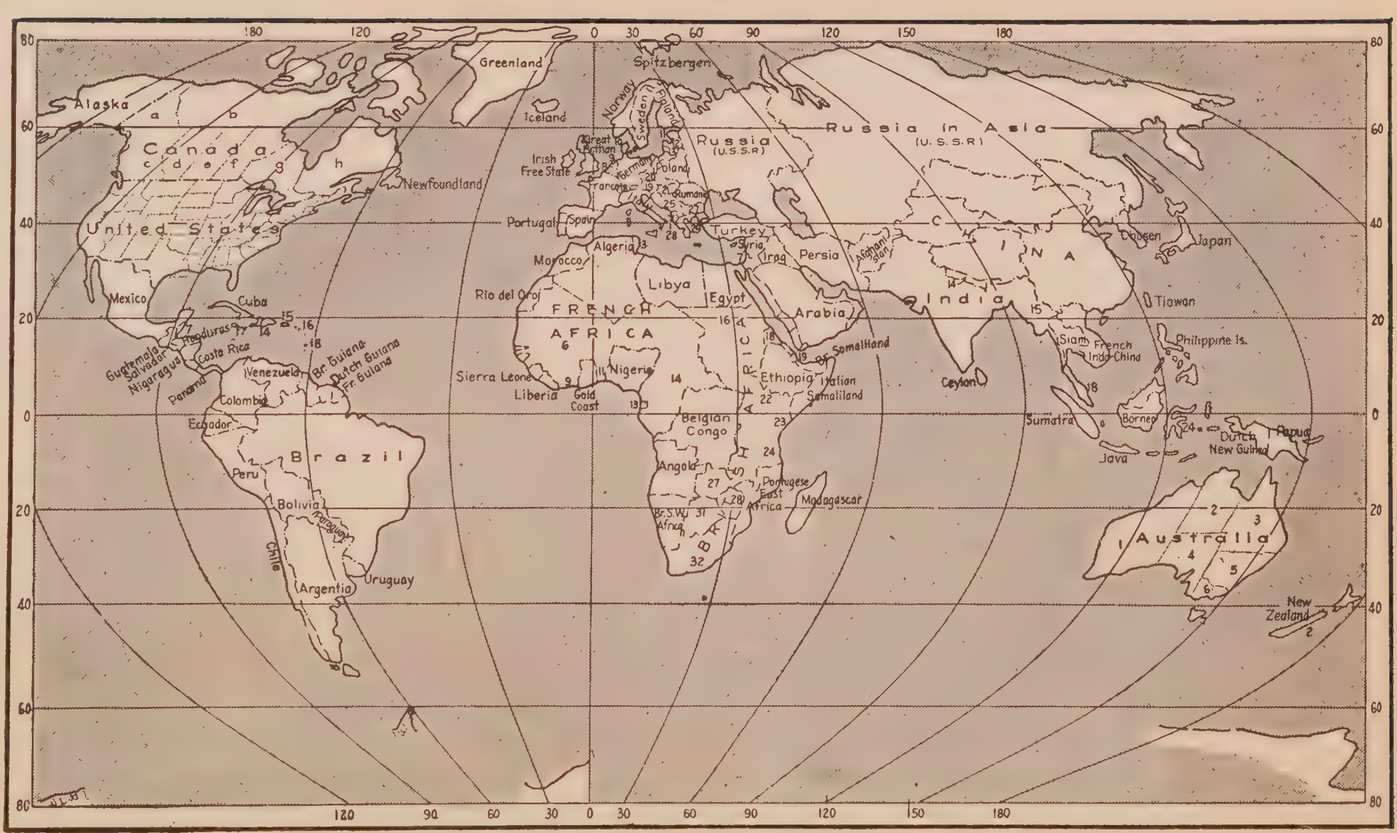


Fig. 9.—The Chief Political Divisions of the World. Denoyer's Semi Elliptical Projection.

THE CHIEF POLITICAL DIVISIONS OF THE WORLD

North America

1. Alaska
2. Canada, and Newfoundland
3. Greenland
4. United States
5. Mexico
6. Guatemala
7. British Honduras
8. Salvador
9. Honduras
10. Nicaragua
11. Costa Rica
12. Panama
13. Cuba
14. Haiti and San Domingo
15. Porto Rico
16. Virgin Islands
17. Jamaica
18. Martinique

South America

1. Colombia
2. Venezuela
3. British Guiana
4. Dutch Guiana
5. French Guiana
6. Brazil
7. Ecuador
8. Peru
9. Bolivia
10. Paraguay
11. Chile
12. Argentina
13. Uruguay

Europe

1. Iceland
2. Spitzbergen
3. Norway
4. Sweden
5. Finland
6. Irish Free State
7. Great Britain
8. Belgium
9. Netherlands
10. Denmark
11. Esthonia
12. Latvia
13. Lithuania
14. Russia (Union of Socialist Soviet Republics)
15. Germany
16. Poland
17. France
18. Switzerland
19. Austria
20. Czecho Slovakia
21. Hungary
22. Portugal
23. Spain
24. Italy
25. Yugo Slavia
26. Rumania
27. Bulgaria
28. Albania
29. Greece

Africa

1. Morocco
2. Algeria
3. Tunisia
4. Libya
5. Egypt
6. French West Africa
7. Sierra Leone
8. Liberia
9. Ivory Coast
10. Gold Coast
11. Dahomey
12. Nigeria
13. Spanish Guinea
14. French Equatorial Africa
15. Belgian Congo
16. Anglo-Egyptian Sudan
17. Ethiopia (Abyssinia)
18. Eritrea (Italian)
19. French Somaliland
20. British Somaliland
21. Italian Somaliland
22. Uganda (Prot.)
23. Kenya
24. Tanganyika
25. Angola (Portuguese W. Africa)
26. South West Africa
27. Northern Rhodesia
28. Southern Rhodesia
29. Mozambique (Portuguese E. Africa)
30. Madagascar (Fr.)
31. Bechuanaland (Br. Prot.)
32. Union of South Africa

Asia

1. Siberia (Russia in Asia)
2. China
3. Chosen (Korea)
4. Japan
5. Turkey
6. Syria
7. Palestine
8. Arabia
9. Iraq (Mesopotamia)
10. Persia
11. Afghanistan
12. British India
13. Ceylon
14. Nepal
15. Burma
16. Siam
17. French Indo China
18. British Malaya
19. Taiwan (Formosa)
20. Philippine Islands
21. Sumatra
22. Java
23. Borneo
24. Celebes
25. Dutch New Guinea
26. Papua (British New Guinea)

Australia

1. Western Australia
2. North Australia
3. Queensland
4. South Australia
5. New South Wales
6. Victoria
7. Tasmania

New Zealand

1. North Island
2. South Island

sion of North America, both sides made strenuous efforts to seize and hold the junction of the Allegheny and Monongahela Rivers where Pittsburgh now is, for that strategic point was the key to the Ohio Valley. And in the recent World War the Allies tried hard to bottle up the Germans and their associates by naval operations in the North Sea and the Dardanelles. Whereas the Germans endeavored just as strenuously to cut off England's food supply by submarine activities in the English Channel.

Many, perhaps most, wars have originated from some *economic motive,* for some reason connected with the food supply or with industry or trade in some important way. Sometimes it has been for the possession of agricultural lands, sometimes for raw materials important to manufacturing, and sometimes for markets considered necessary to foreign commerce. Now, one of the great dangers in war is the severe economic pressure that may be felt by large classes not in the armies or navies, but in the shops and factories at home. And one of the great dangers of unsatisfactory conditions leading to war is that masses of the population struggling under economic inequalities and the relatively high cost of living may come to feel that war might offer them relief through higher wages, better markets, or fewer competitors. If the majority of people in a country should get such a notion, whether right or wrong, a democratic government would be likely to yield to their desire, and some pretext for war be found. In these days of submarines and airplanes, of gas and poison, it would be hard to protect the country behind the lines. Hence, in future wars all parts of the population will likely be in danger from the enemy's military activities.

Historical activities.—All of the foregoing activities whether economic, legal, political, or military, have characterized human society for ages past and, consequently, when looked upon in the time relation may be considered events of history. For *history,* from one point of view, means the sum total of the past experiences, events, achievements, or activities of humanity. So the term " historical activities " includes not only the fundamental social activities named above, when considered throughout a period of time, but also all other activities, such as those which may be called moral, æsthetic, and cultural activities, the objects of which are to improve the moral standard, the tastes, or the intelligence of the community.

Any of the foregoing activities of man may be studied from the point of view of their relations to environment during a period of their history. When studied in this way they form the material of *historical geography.* In this branch of geography, however, as in any other division of geography, it is necessary to keep in view the environmental aspects. As to just what is meant by environment, the following pages will attempt to give some idea.

Chapter III

MAN'S ENVIRONMENT

Introduction.

Environment in social causation.—The various characteristics of man, the nature of his distribution over the face of the earth, the variety of his activities, and the extent of his progress are sufficiently striking to merit consideration, and consequently, attempts at explanation. Since all of man's activities occur in some place and amid some surroundings, it naturally follows that the conditions of habitat or environment must be of vital, if not of fundamental, importance in any *theory of social causation,* that is, in any attempt at the systematic account or explanation of the distribution, activities, and accomplishments of man or society.

It must not be supposed, however, that environment alone can furnish all of this explanation, although in the past some geographical writings have intentionally or unwittingly seemed to give that impression. Occasionally, this view, it must be admitted, appears even yet. For example, the advertisement of a recent textbook in geography, defining environment, magnifies its importance, thus: "The authors believe that the physical features of the continent, such as Climate, Topography, Soils, Minerals, Coast Line, Water, and the feature of the native plant and animal life are the main elements in environment. From these are evolved social, political, economic conditions as well as the characteristics of the inhabitants." This view considered alone might be thought a narrow geographic determinism. The words of the authors themselves, however, as stated in the text, give a more nearly correct impression, for they wisely say: "However, geographic environment does not explain everything. In fact, it is highly probable that no one thing explains any particular phenomenon in life. Life is complex, and there are a multitude of influencing factors, including the human element itself. These should all be recognized and given due weight."

Other elements necessary to explain social progress.—In the evolution of social life various biological, psychological, and cultural factors must be considered as well as the rôle of environment. Thus we must take into account *heredity*, or the appearance in offspring of characters whose differential causes are found in the germ cells. Heredity probably furnishes the basis and sets the limit to human or social development. And numerous other factors, some objective and some subjective, contribute to the explanation of why men are what and where they are, and why they thrive more in some places than in others. Some of these other factors to be considered are racial characteristics, natural and social selection, instinct, custom, imitation, invention, ethics, religion, government, education, and social ideals. As a prominent sociologist, Professor Frank H. Hankins of Smith College, expresses it: "The whole life of any society can not be understood except as some account is taken of the physiographic conditions to which it is adapted, the biological factors which determine its potentialities, the general psychological principles which reveal the mode of functioning and behavior of the human mind at all times and places, and those modes of behavior characteristic of social groups." There are various social sciences devoted to the study of particular aspects of the human relationships of these factors.

The environmental elements.—The special field of geography being to consider man or society from the standpoint of environment, it becomes important to list or classify the environmental elements. These factors or elements of man's environment may be classified as follows:

ELEMENTS IN MAN'S ENVIRONMENT

Main Divisions	*Subdivisions*
A. Locational	1. Place.
	2. Area.
	3. Distance.

- B. Climatic
  - 1. Composition of Atmosphere.
  - 2. Light.
  - 3. Temperature.
  - 4. Pressure (atmospheric).
  - 5. Winds.
  - 6. Moisture (including humidity, cloudiness, fog, and precipitation).
- C. Physiographic
  - 1. Land Forms.
  - 2. Water Forms.
  - 3. Soils.
  - 4. Minerals.
- D. Biological
  - 1. Plants.
  - 2. Animals.
- E. Social
  - 1. Man.
  - 2. The Works of Man.

The order in which the elements are listed is entirely arbitrary, with one exception. Location appears first in the classification because it is an environmental element of paramount interest. The first thought that occurs to us about a place or object is probably—"Where is it?" After the position or location has been established our interest generally centers on the elements which are most attractive or predominating. For example, a rainstorm would emphasize the influence of one of the climatic elements, a dense forest would involve one of the biological elements, a city would bring out the importance of the social elements, and so forth. But in all instances these environmental elements are closely interrelated, and are constantly changing. They are analogous to a theatrical stage on which man is the center of attraction. If the artist has been as skillful as the maker of our environment or landscape, there is generally a striking relationship between the actor's performance and his surroundings. An understanding of this relationship, (1) its nature, (2) its cause, and (3) its effect, constitutes the main purpose of geography.

The Relation between Man and the Environmental Elements.

The geographic point of view.—A few illustrations of the relationship between man and his environment may indicate the geographic point of view. Detailed information and the interpretation of the geographical influences have been reserved for the chapters which follow, where each major group of elements in environment is considered separately to make it easier to understand the relationship between man and his environment. Before considering this relationship, however, it seems worth while to distinguish between an environmental element and a geographic factor or element—terms which are constantly used in a geographic study.

Distinction between environmental factors and geographic factors.—Since geography as a science concerns the *relations between* man and his environment, it naturally follows that in this study we have to consider both the human factors and the environmental factors. It should be noted that *both are geographic factors,* whenever there is expressed a recognizable relation between them. Thus, climate influencing agriculture is not only an environmental factor, but also a geographic factor, because it is related to a human activity; on the other hand, a group of Slovaks mining coal constitute a human factor, an economic factor so-called because they are engaged in labor, but at the same time they are a geographic factor because they are utilizing a natural resource of the environment. That is, in both cases there exists this relation between environment and man, the study of which constitutes the theme of geography. The geographic relationship may be either the environmental factor influencing man or the human factor utilizing the environment.

Location as a geographical factor.—Location is not a material element in man's environment. It cannot be carried from one place to another. It is recognized as an invisible element, referring to place, area, or distance of the other environmental elements. It is in reality an aspect of all matter, because the mere existence of something indicates that it must be somewhere.

Frequently, location acts as a valuable index in disclosing the nature of the other environmental elements. Whether man is enjoying the balmy atmosphere of southern California or is being depressed by the humid air of Amazonas is a matter of location. The accessibility of markets, schools, and means of transportation, all depend upon location.

Climatic factors—*Influences on health.*—Man's health, the first requirement for a life of contentment and service, is profoundly affected by climate. Scarcely a moment's reflection is necessary to recall epidemics of influenza, malaria, typhoid fever, and general physical disturbances following adverse atmospheric conditions. A sudden change in temperature is frequently responsible for colds. According to Professor Ellsworth Huntington, one of our foremost geographers, meteorologists and authors, weather caused the death of 75,000 people in the United States in two months in 1927. He says that the winter of 1926 was open and warm until the middle of February. Then came an unusually cold and inclement period which lasted till the middle of April. This led to an unusually large number of colds, much pneumonia, and some influenza, as well as other illnesses. The result was that in the spring the number of deaths was about 75,000 greater than normal.

These disturbances may arise from the direct effect of weather on man as well as the effects on his surroundings, producing conditions favorable for the source of ill health. The indirect effects are more responsible for disease than the direct effects of weather and climate. This is well illustrated in the warm, rainy tropics where the survival of inefficient means of sanitation, poor living conditions, and ill-fitted diet, further the development and spread of disease. Generally, the number of deaths from hookworm, malaria, and typhoid fever is greater after the rainy season in these regions.

The composition of the air is also an important factor in the maintenance of health. Within many of our modern cities, there is a disgraceful smoke and dust nuisance. As a result, the number of throat and pulmonary diseases is in some localities on a rapid increase. Dust is one of the best carriers of bacteria, but little precaution has been taken to prevent this detriment to health.

Light is another effective element of climate. It is perhaps more essential to life and health than any other thing except food, air, and water. Man cannot live in darkness and remain well. The medical profession has declared the ultra-violet rays an absolute necessity for human life. Patients are treated with these artificial rays of sunlight with remarkable results in the restoration of health. Many kinds of bacterial activity do not take place in sunlight, which acts as a disinfectant or purifier. Light, with the exceptions noted above, is probably man's most useful single gift from nature. It affects not only man's health, but also his characteristics and activities.

Racial characteristics and climate.—It is commonly assumed that the color of the negroes is caused by long residence in tropical countries where the ultra-violet rays are intense. The darkness of the skin may act as a protection, for too much ultra-violet is dangerous. Dr. C. E. Woodruff of New York City has made an instructive study of sunlight, blonds and brunets. He says " in those countries which average less than 1250 hours of sunshine each year the blonds flourish. Such countries are Norway, Sweden, parts of northern Germany, and northern parts of Ireland and Scotland. In the countries where the sunlight totals more than 1700 hours a year blond peoples tend to die out, even if migration takes them into these sunny lands. But, for the brunets, the sun is necessary to contentment. When there are more than 2500 hours of sunshine a year the dark-skinned people do well; the blonds die out or move into more favorable areas." Free and Hoke, in their interesting book on weather, say " it is probable that the human race, when it originated, as scientists think somewhere in the highlands of Central Asia, was of a light brown or deep yellow color. From this origin all human migrations have gone out, millennium after millennium, to people other continents. One stream of migrants filtered into Africa. On the way to that continent, and after they reached it, this branch of the original yellow-brown race experienced some of the intense and continuous sunlight of the earth. It turned their skin black, and they are now the African negroes.

" Another stream of the yellow-brown first men of Asia migrated northward and northwestward into northern Europe. Here the climate was cold and cloudy. There was very little sun; sometimes none at all for days at a time. Gradually the brown and yellow pigment of the skin faded. The hair and eyes were similarly bleached. Thus, scientists believe, arose the blonds."

Racial differences other than color, such as the characteristics of the nose, are thought to show the effects of climatic influences. The negro nose, low and flat, is open and direct in its internal structure. The white nose is longer, thinner, and has a more convoluted interior. As a result, the negro nose is better suited for warm, moist climates than the white nose which is better fitted for a colder and drier climate.

Activities.—Climate affects human energy. The desire "to wait until to-morrow" is frequently the result of the effects of warm, humid atmospheric conditions. Oppressive weather and low student grades show a striking correlation, although low grades or a lack of energy cannot always be attributed to weather or climate. However, when the air is stimulating there is generally more desire to work. An invigorating climate and progress are inseparably related. In the warm, humid weather the degree of energy is low, and our minds are inactive, with the result that our accomplishments are limited.

Practically all forms of gaining a living are affected by climate. The activities of agriculture, manufacturing, mining, and the like are much influenced by climate or weather. The types of products, time of production, and sales records are generally closely related to climatic conditions. The business of recreation is strikingly affected by weather. In order to guard against a financial loss, due to adverse weather conditions, a protective insurance is often carried by the promoters. Even the success of the performers may be partly due to weather. It has been said—and possibly too often—that football games have been lost because of a muddy field or strong winds.

The advance in civilization has taken place in those regions of high climatic energy, that is, where the climate has the effect of giving people health and energy. Professor Ellsworth Huntington has constructed two maps, one showing the areas of progress or civilization, and a second, showing the areas of high climatic energy. The designated areas on these maps are nearly identical in location. The areas of high climatic energy which include most of the United States, southern Canada, most of Europe, Japan, southeastern Australia, New Zealand, and a portion of Argentina are also the areas of marked civilization.

Migration of people and climatic factors.—The effects of climate on the migrations of people are constantly before us. The southern invasion of pleasure- and health-seekers during the winter months to avoid the low temperature of the north illustrates the influence of climate. The movement of laborers from the wheatfields of the United States to Canada is an adjustment to climatic effects. In Argentina the wheat-growers secure laborers from Italy during the harvest season. After the wheat has been cared for these Italian workers return to their native country. It can be said that nomadism is largely a human adjustment to climate, whether it is from plains to mountain valleys or across deserts. The early migration of primitive man from his original home in Asia has been attributed to the change in climate. The dispersion of races in general has been explained on the basis of climate. The early records of the number and class of immigrants show a marked relation to adverse climatic conditions in the native countries of the immigrants. For example, in the nineteenth century the large Irish immigration into the United States was due primarily to excessive rains in Ireland. Abnormal crop failures on account of adverse weather have had their influence on the number of emigrants. It should be kept in mind, however, that climate is not the only factor affecting man; race, religion, government, education, and many other important geographic and nongeographic factors must be given due consideration in accounting for man's distribution and activities.

Effects of physiographic elements on man—*Land forms.*—The relief of the land may favor or retard human activities. High mountains, lofty plateaus, and deep, narrow valleys are effective barriers in the path of man's progress. The towering peaks of the Andes and Himalayas, and the lofty plateaus of Tibet and Bolivia offer little, if any, encouragement for human occupation. The Grand Canyon, over a mile deep and nearly

13 miles wide in places, is one of nature's greatest phenomenal obstacles. Rugged relief reduces the area of land that can be used for agriculture. The inherent value of broken or irregular topography rests in mining, grazing, and lumbering industries. In a number of cases the rugged lands prove attractive summer resorts, an activity of increasing importance of the so-called less useful lands. The more uniform or level land forms, such as plains and the bottom of valleys, constitute the chief seats of human interest; here are the extensive agricultural areas, the large, progressive cities, the manufacturing centers, and the efficient means of communication and transportation.

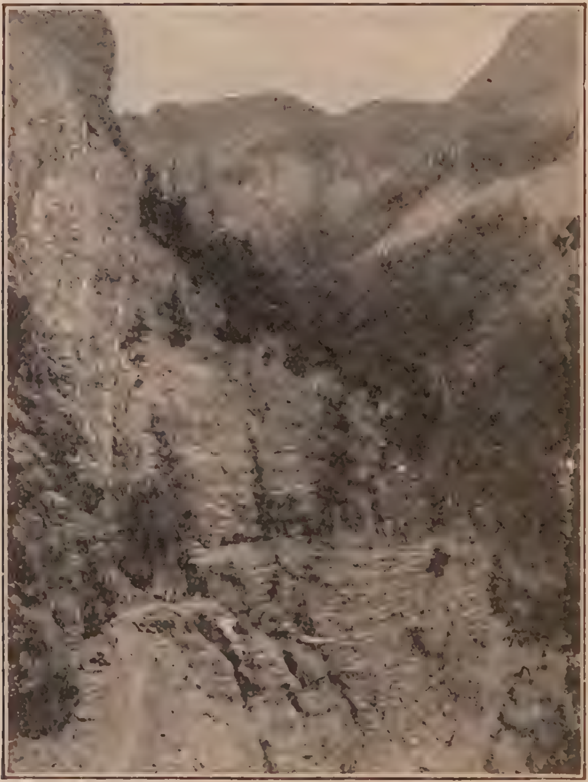
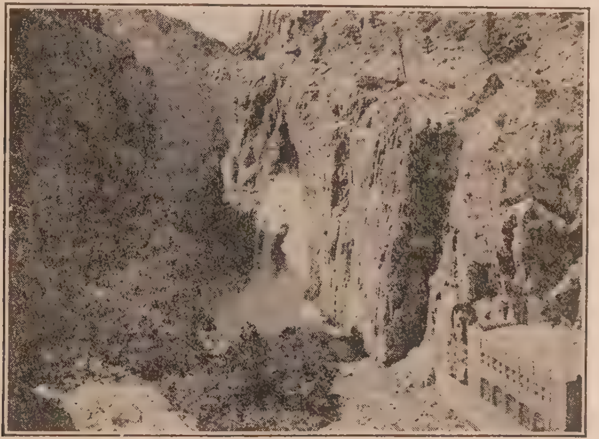


Photo by W. I. Hutchinson, courtesy U. S. Forest Service.

Fig. 10.—Bear Creek Trail, Winding Along the Face of Sheer Rock Cliffs in Colorado; Illustrates Transportation Difficulties in Mountains. The man and the mule barely find a foothold on the narrow path on the ledge at the left

Water.—Man's dependency on water as an essential part of his diet is in itself sufficient to establish water as an important geographic factor. The location of trails across deserts is largely in accordance with water levels where the nomads may obtain their supply of water. Refreshing springs or wells have always been a source of attraction. The presence of an ample supply of water for civic purposes is one of the absolute necessities for urban development.



Courtesy of United States Reclamation Service.

Fig. 11.—Shoshone dam and $250,000 power plant, Shoshone reclamation project, Wyoming. The Shoshone dam is a rubble concrete arch, 328 feet high, with a crest length of 200 feet and a volume of 78,576 cubic yards. The reservoir formed by this dam has an area of 6,600 acres and a capacity of 456,600 cubic feet of water.

Waterways may be considered the natural avenues or channels of transportation. Their presence has attracted man's attention with the result that cities have developed on favorable river sites such as a high bank, a sharp curve or meander, at the junction of tributaries, and at the mouth. The construction of canals to further river, lake, and ocean transportation indicates the relation of water to man's activities.

The utilization of water for irrigation purposes, making it possible to reclaim thousands of acres of arid and semi-arid land is another geographic importance of water. In numerous cases where water is stored for irrigation, there are found plants, utilizing water for power purposes (see Fig. 11).

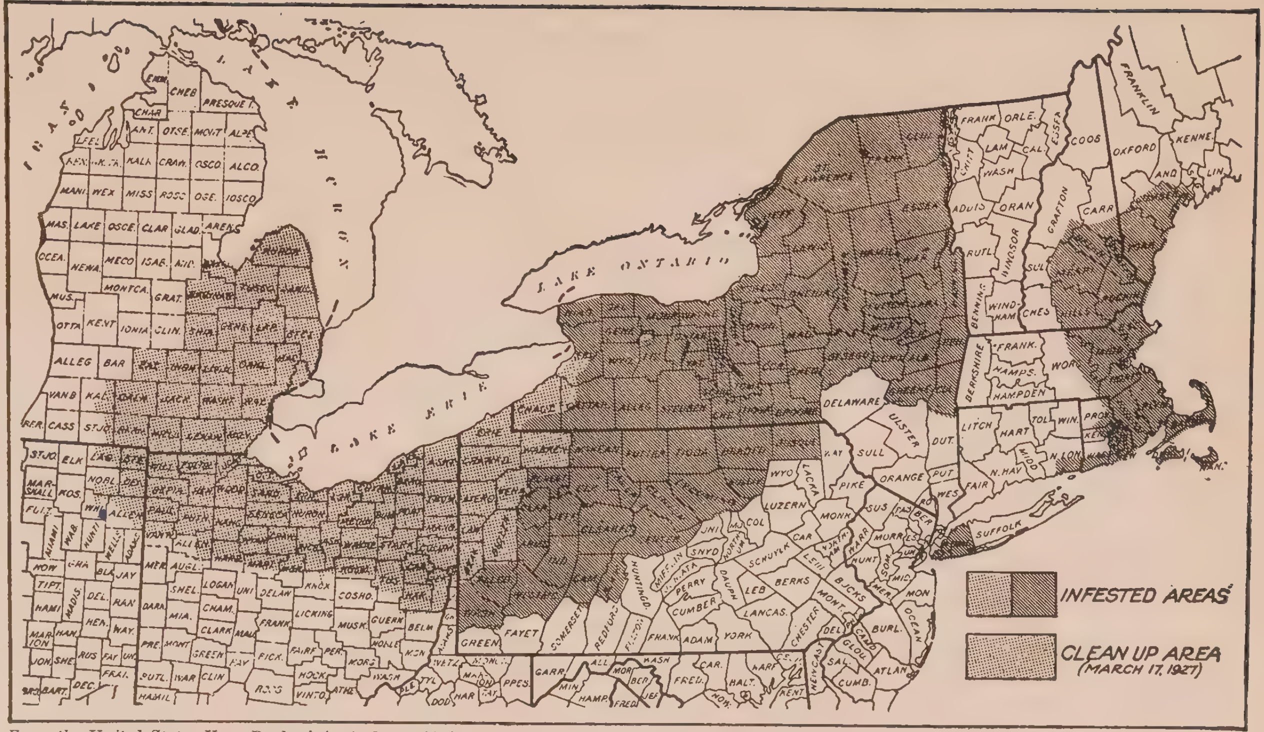
Soils.—The nature of man's most fundamental industry, agriculture, is profoundly influenced by soil conditions. A survey of the distribution of crops of a country, or on an individual farm, will show a close correlation between the variety of plants and the types of soils, such as hay crops on clay soils, corn on loam soils, and vegetables on muck soils.

Soils not only influence the kind of farming practiced, but also the prosperity of the industry. It can well be said that soil conditions go far towards determining industrial supremacy, affecting agriculture directly, which, in turn, affects manufacturing, commerce, and life's activities in general.

Minerals.—Minerals have attracted the attention of man throughout the ages. Early adventures were frequently made in search for mineral wealth. Copper, gold, and silver have influenced man to the extent that he has endured the heat of the tropics and the cold of the frozen north to secure these earthly materials.

It is scarcely necessary to say more than that, in brief, the industrial progress of a nation is largely dependent on mineral resources. Iron and coal are recognized as industrial necessities, since no modern nation has advanced far without the use of these materials. The increasing international interest in the conservation of mineral resources is indicative of the importance of minerals in man's environment.

Plants and animals as important geographic factors.—There are numerous forms of human activity that depend on plants and animals. Individual persons, as well as entire communities, are engaged in industries in which the biological elements are necessities. The lumber industry, crop farming, horticulture, and gardening are a few of the occupations dependent upon the plants. The fur industry, the fishing industry, the dairy industry, and the meat-packing industry suggest the importance of animals as elements affecting the nature of man's activities. Both plants and animals are essential food products. Man is physiologically dependent upon the plants, which are a sort of transformer of air, rocks, and water into valuable foods for man. Animals are equally important in providing essential food products.



From the United States Year Book of Agriculture, 1927.

Fig. 12.—Area Infested by the European corn-borer in the United States. Congress, alarmed by the threatened invasion of the great Corn Belt, passed the act of Feb. 23, 1927, appropriating $10,000,000 for the "eradication or control of the European corn-borer." This was the largest insect-control project ever undertaken. It was preceded and precipitated by the almost entire destruction of the corn crop of southeastern Ontario, Canada, and the invasion by the pest of almost half of Ohio and Michigan and its encroachment into northern Indiana.

Not all plants and animals are useful. Numerous obnoxious weeds such as the daisy, thistle, dandelion may indirectly affect man by directly reducing the yield of his crops. It is also true that these weeds may require a considerable amount of work on the part of man to remove them from his cultivated field or lawn. Microörganisms may introduce serious disease conditions. Their effect on man is possibly more destructive than the bigger forms of animal life. Various insects, particularly the malaria mosquito, the boll weevil, and the corn-borer may directly or indirectly affect man's progress. Both malaria and yellow fever are mosquito borne diseases. The corn-borer has recently threatened the corn area of the central United States with failure. The boll weevil is responsible for certain changes in the cotton-producing regions of the south.

Man and his works as environmental factors—*Man.*—The term " man " as used here does not refer to the human race collectively, but to man as an individual or group. If the word " man " had reference to mankind as a whole, there would obviously be no one else to act as an environmental factor to him or to be, as one might say, environed by man. But to think of man as a single person, or as groups of people, he (or they) may form an effective part of the environment of others. His activities are influenced by the presence and behavior of other members of human society. " To understand man we should view him as an integral part of the environment."

When the Puritans landed on the shores of North America they were confronted with many new environmental factors. One of these factors included the American Indians. To the early settlers, these native American Indians were as much a part of the environment as the trees, hills, or water. It would be impossible to give a true account of the lives of the Puritans without referring to their relations with the Indians.

A farmer recognizes the importance of a nearby community where he can sell his products and buy the necessary food, clothing, and implements. The members of this community represent an effective factor in his environment. The value of his land may be decidedly affected by the presence of this community. In fact, he may eventually retire from farming and sell his farm for real estate purposes—thus responding to the influence of his environment.

The influence of man on man is even greater in cities than in rural districts. Scarcely a moment of urban life is spent without being reminded of the presence of man. The crowded street cars, the perpetual hurry, the limited living quarters, and the public forms of recreation are a few of the conditions which man must meet in cities. His home, the city, represents largely a synthetic environment in which man is the most effective factor.

Works of man.—The activities of man differ fundamentally from those of plants, animals, and other environmental factors, in having a more prominent aspect of construction and production. These artificial forms, including such as buildings and forms of communication and transportation, play an important part on the stage of human development. It is sufficient at this time to say that the works of man constitute an important factor in environment, one that cannot be disregarded if a complete picture of man's habitat is desired.

Interrelation of Environmental Elements.

Relative importance of environmental elements.—The frequent expression " climate is the most important environmental element " is subject to conjecture, if unqualified. It may be true that climate is the most important element, but not in all cases. The reason for this assertion is based upon the fact that the environmental units—air, land, and water—must be a part of every environment. They not only constitute the physical basis of life, but also affect the nature of all environmental elements. Their interrelation has been well expressed by Powell:[1]

" The envelopes of air, water, and rock are so distinct that they can be clearly distinguished; and yet, when they are carefully studied, it is discovered that every one encroaches upon the territory of the others, not only by interaction, but also by interpenetration. It has already been shown that the water penetrates deep into the rock. Every spring that falls from the hillside gives proof that the rocks above its level hold water, which they yield slowly as a perennial supply; every well proves that there is water below; every artesian fountain shows the existence of underground waters; and every boring in the crust of the earth, and every excavation in underground mining, discovers the presence of water.

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[1] *Annual Report of the Smithsonian Institution* (1895: 22–23).

"Wherever water flows, air flows with it, and all natural waters are permeated with air.

"The aqueous envelope is everywhere permeated with rock, which it holds in solution or suspension, and there is no natural water absolutely pure. The sea is full of salt. Salt lakes are more than full of salt, and so they must throw it upon the bottom; and the waters hold lime and many other substances. Not a drop of pure water can be found in the sea; not a drop of pure water can be found in a lake; not a drop of pure water can be found underground; it is all mixed to some degree with rock.

"All natural waters are aërated. No drop of water unmixed with rock and air can be found, except by the process of artificial purification.

"But surely there is pure air? *None at all.* There is no natural air unmixed with rock and water. All the air that circulates above the land and sea, within the ken of man, and all the air which circulates underground, is mixed with rock and water.

"Pure air is invisible; it will not reflect; it is transparent, but will not convey light. Light is conveyed through the atmosphere by ether, and is reflected and refracted by rock and water; and it seems to be largely affected in this manner by rock. If the ambient air of the earth were pure, there would be no color in the sky, no rainbow in the heavens, no gray, no purple, no crimson, no gold, in the clouds. All these are due largely to the dust in the air. The purple cloud is painted with dust, and the sapphire sky is adamant on wings.

"Land plants live on underground waters; were there no subterranean circulation of water, there would be no land plants. Fishes live on underwater air; were there no circulation of subaqueous air, there would be no fishes in the sea. The clouds are formed by particles of dust in the air, which gather the vapor; were there no dust in the air, there would be no clouds; were there no clouds, there would be no rain."

Since the foregoing fundamental environmental units are interrelated, and again since they affect the nature of the climatic, physiographic, biological, and social conditions in the environment, it necessarily follows that these environmental elements are also interrelated. Climate is related to the physiographic elements, biological elements, and the social elements. Each one of these elements, namely, physiographic, biological, and social, is in turn related to climate. Thus, each element is dependent upon each other element. Their scale of importance and interrelationship is well balanced.

Man's Changing Environment.

Dynamic nature of environment.—One of the first principles of geography, as previously stated, is continual change. This dynamic characteristic as observed in man's condition and behavior is partly the result of the instability of man's surroundings. His habitat or environment is constantly changing. Some changes are rapid and impressive, while others are imperceptibly slow and apparently ineffective. Land and water forms are comparatively constant environmental elements. Climate, soils, minerals, plants, animals, man and his works are recognized as variable environmental elements. Since location is a part of all elements, it necessarily follows that it changes or remains constant, depending on the condition of the elements to which it pertains.

Tragedies of nature.—Quick and sudden changes in the environment have impressed the minds of nearly every one. A tornado sweeping its way across a site of human occupation may destroy buildings, uproot trees, and bring terror if not death to those who fall within its path (see Fig. 13). Floods such as those which have occurred in the Ohio valley and the

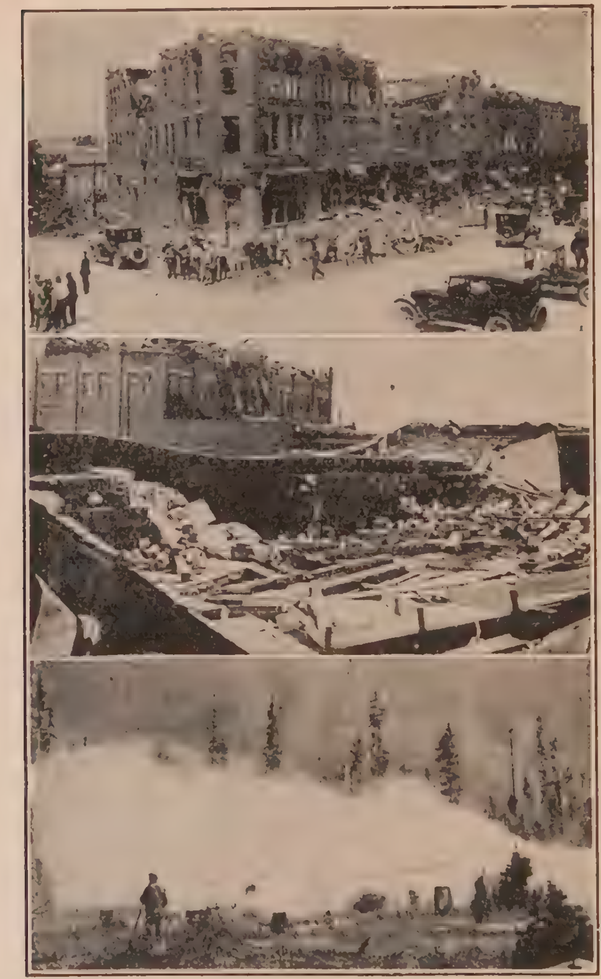

Fig. 13.—Effects of Tornadoes and Forest Fires.

Upper.—Scene in business section of Lorain, Ohio, after tornado that swept southern shore of Lake Erie in 1924.

Middle.—Ruins of the H. J. Heinz plant, Princeton, Ind., damaged to the extent of over a million dollars by the tornado of March 18, 1925. This was the largest plant in the world devoted exclusively to the making of tomato catsup. This tornado killed about 25 people, injured some 200 others, and rendered homeless many more. (Photos by courtesy of W. H. Alexander.)

Lower.—Backfiring to check a forest fire, Kootenai National Forest, Montana. During the six years ending in 1922, forest fires in the United States averaged 33,500 annually, burning over more than seven million acres. (Photo by courtesy of United States Forest Service.)

Mississippi basins have laid waste thousands of acres of valuable land by the deposition of sand and gravel on fertile soil, by the destruction of plants and animals, by the inundation of homes, and the suppression of human life. The earthquakes at San Francisco, the volcanic eruption of Mt. Etna, the landslides of the Alps are responsible for marked changes in man's environment. Forests of great economic importance have been completely destroyed by fires. The terrifying conflagrations of cities, as those which have taken place in Chicago, Boston, and Baltimore, stir the human imagination to the full realization of the instability or nonpermanency of man's environment.

Normal changes in man's environment.—Other changes less dramatic than the tragedies of nature are slowly taking place, and have continued to do so throughout the history of the earth. Some land now far above sea level was at one time covered with thousands of feet of water. Mountain building, as well as mountain destruction, has left its impressions on the surface of the earth. Deserts have replaced humid lands. Soils have been formed, and in many places they have been carried away by the forces of wind, water, and ice. But all of these changes have taken place largely with imperceptible slowness involving millions of years. It can be stated that since the beginning of human history there have been no striking changes in the major land and water features of the earth. Mountains, plateaus, plains, valleys, oceans, seas, lakes, and rivers are much the same to-day as they were when man first appeared as an actor on the environmental stage.

Climate has been less stable than land and water forms. There seems to be the opinion among meteorologists that even within historic times climate has passed through changes of an appreciable degree. At least, there are records of unusually wet and cold years followed by dry and warm years. The daily weather changes are more pronounced than changes over a long peroid of time. A cold day may pass suddenly into a period of warm weather. Cloudy days, rainy days, foggy days, bright days, and the like have been experienced by nearly every one.

Soils and minerals are less variable than climate. Their manifestations of change are extremely slow, and are generally the effects of man's activities, more so than the effects of the natural forces. Indeed, where floods, or torrential rains have been active, there may be decided changes in the soils and mineral-character of the affected region.

Man and his works constitute the most impressive normal changes in the human habitat. The increasing cities, the efficient means of transportation and communication, the improvement in harbors, the reclamation of land, the destruction of forests, and the productive agricultural fields illustrate the effectiveness of man's activities in changing the human surroundings (see Fig. 13).

Summary.—In the foregoing discussion an attempt has been made to disclose the fundamental characteristics of man's environment as consisting of five major groups of elements, namely, (1) Locational, (2) Climatic, (3) Physiographic, (4) Biological, and (5) Social. These elements affect the distribution and activities of man; they are all interrelated; and they are constantly changing. Again, it may be well to state that the central theme of geography is the study of the reciprocal relationship between man and his environment. The term reciprocal implies that attention is given not only to the effect of the environment on man, but also to the effect of man on his environment.

In the remaining chapters, the following fundamentals should be carefully observed: (1) the geographical or reciprocal relation between man and his environment; (2) the nature of the geographical relationship; (3) the cause of the geographical relationship; and (4) the consequences of the geographical relationship. In order to fulfill these desirable requirements, it is necessary to study the characteristics of the environmental factors, as well as the geographical relationship. Since all the works of man and all the other environmental factors are so universally thought of in reference to place, it seems appropriate to begin with some consideration of the geographical aspects of location.

CHAPTER IV

LOCATION AS A GEOGRAPHIC FACTOR

Introduction.

Meaning of location.—The term *location* includes such things as position, shape, area, distance, accessibility, proximity, and remoteness or isolation. Location as a geographic factor applies not only to man and his affairs, but also to all the other environmental factors. It involves the answers to questions like: Where? How large? How far? In what direction?

Importance of location.—Location is a geographical factor of fundamental importance. It largely discloses the nature of man's environment, and profoundly influences the character of his activities. The hardy Norsemen were seafaring people because of their location on the broken shores of Scandinavia. The ideal climate and soil conditions for corn-growing in the state of Iowa are matters of location. If man's home is located in the Sahara Desert, he can scarcely pursue either the maritime interest of the ancient Norsemen or the noble activity of the Iowa farmers.

The significance of location is well expressed in the choice of residence. One need only start out to buy a home to find out that location has a very decided influence on its price. It is of material difference whether the home is favorably located in respect to transportation conveniences, and nearness to stores, schools, and desirable neighbors. The amount of sunlight and the extent of exposure to winds, too, are noteworthy factors of location which may determine the degree of human contentment.

The business man is equally concerned with location. The department stores locate on a given street because of prestige and unified influence on buyers. The ten-cent stores frequently make very careful surveys, even counting the number of people passing different corners in a day or a week, before deciding where to locate a new store. The manufacturer builds his plant according to geographic advantages, such as nearness to fuel, raw material, and market. Location affects distance, and distance is a geographic factor that often determines profit. If a manufacturer has to bring his raw materials from a long distance, that increases his costs, and costs must be subtracted from his sales before he arrives at profits. Our railway-freight rates are commonly based on distance, and they affect the costs to both producers and consumers.

Location often surpasses in force any other single geographic factor. It affects not only individuals and industries, but also regions and nations. The strategic position of the West Indies would maintain their importance, irrespective of any commercial value. Miss Semple says[1] that Russia, with a vast area, an abundance of resources, a large population, has suffered retardation of progress because of her "position on the outskirts of Europe, remote from its great centers of development," but subject to the social influence of the inferior Asiatic neighbors. The intracontinental position of Germany with her rapidly growing population and her consequent desire for "a place in the sun" had much to do with the outbreak of the Great War. The devastation of southern Belgium during the World War was in part due to her location between France and Germany. The northern position of Alaska is a geographic disadvantage which tends to outweigh the force of her resources. The position of little Holland at the mouth of the Rhine, opposite the Thames, and on the water route from the North and Baltic Seas to the Atlantic, contributed greatly to her becoming at one time the world's leading commercial nation, and to enabling her to retain to this day a colonial empire far larger than herself in area and population.

Location is dynamic in nature. It may change in importance or effects, according to the distribution of man and his activities. Location involves both accessibility and isolation, and what meant the latter for a country in its early history may spell the former in its later development. The transfer of the higher civilization from the subtropical to the temperate lands, the movement of maritime interest from the inclosed seas to the open oceans, and the improvement in methods of transportation illustrate this changing nature of location. The trend towards relocation of business establishments, and the consequent depreciation or appreciation in value of land, may further indicate the instability of location. Someone has said that the life of a good residential street is only about a generation. Location may be classed as a sort of invisible, intangible element in environment, but it is none the less a vital factor in many human activities.

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[1] *Influences of Geographic Environment, p.* 129.

Location and Man's Distribution.

Where people live.—In the first place it should be noted that man and his activities are practically limited to the surface of the earth, which comprises some 197,000,000 square miles. So far, he has penetrated not more than 6000 feet below the surface, nor has he ascended more than eight miles above it. Perhaps the most important, and certainly the most obvious, geographical characteristic of the earth's surface is its division into land and water.

As there is only about one-third as much land area as water, man's habitat is thus further restricted, for everyone knows, and a look at the population map verifies the fact, that it is on the land that people dwell. This map also shows clearly at a glance that by far the largest part of the land is in what is called the Northern Hemisphere. It brings out just as clearly, too, the greater density of population in the Northern Hemisphere. The term "Northern Hemisphere," of course, means that part of the earth between the equator and the north pole.

The poles and equator as reference points.—The north pole is of particular importance geographically because it is a fundamental point from which the location of other places on the earth's surface is determined. It is the end of the diameter, or *axis,* on which the earth rotates once a day. This axis of the earth points in general towards the North Star at all times; hence, the end of the axis next to the North Star is called the north pole. Likewise, the opposite end of the axis is called the south pole, and is approximately under the South Star.

In the daily rotation of the earth on its axis a ray of sunlight striking a point on the surface halfway between the poles (as at *E*, Fig. 14) describes a circle around the earth, which is called the *equator*. This equator is a fundamental reference line, and divides the earth's surface into the Northern and Southern Hemispheres.

The polar and tropical circles.—A further examination of the map in Figs. 1 and 2, showing the distribution of population in the Northern Hemisphere, discloses the fact that most of its inhabitants live between the tropic of Cancer and the Arctic Circle. These are two important reference lines fixed by the position of the earth's axis with reference to the sun; by the rotation of the earth on its axis; and also by another motion of the earth; namely, its annual revolution around the sun. The path of this annual revolution of the earth is called the earth's *orbit*, which is an ellipse at one of whose foci the sun is located. The plane of the earth's orbit, that is, the surface of this ellipse is known as the *ecliptic*, or plane of revolution. During the annual revolution of the earth, its axis is always inclined 23½° from a perpendicular to the plane of the ecliptic. This constant 23½° inclination of the earth's axis brings it about that when the earth is in one position of its orbit, called the aphelian position, the rays of the sun (which are practically parallel when they reach the earth, on account of the great size and distance of the sun) extend for 23½° beyond the north pole (as at *A*, Fig. 14) and fall 23½° short of reaching the south pole (as at *B*, Fig. 14). When the earth is in this position, the rotation of the earth on its axis results in the ray of sunlight, which just reaches the point *A*, describing a circle around the earth 23½° from the north pole, called the *Arctic Circle;* while at the same time the ray striking *B* describes a circle 23½° from the south pole, called the *Antarctic Circle*. These two circles are the *polar circles*.

At this time, approximately June 21, the sun's rays strike the earth's surface at A and B at a tangent, that is, horizontally; while at point C, halfway between A and B, the sun's ray strikes the earth vertically, that is, perpendicular to its surface. Consequently the same rotation of the earth, during which points A and B describe the polar circles, results in point C describing a circle about the earth 23½° north of the equator, called the *tropic of Cancer,* and at the same time in point D, just opposite C, describing a circle 23½° south of the equator, called the *tropic of Capricorn.* These two circles 23½° on either side of the equator are the tropical circles. These and all other circles on the earth's surface parallel to the equator are known as *parallels.*

It has been said above that most of the people of the Northern Hemisphere live between the arctic circle and the tropic of Cancer. The land area of this belt, about 26,000,000 square miles, is just about equal to its water area, and contains some 65 per cent of the world's population. This is quite a contrast to the corresponding part of the Southern Hemisphere between the tropic of Capricorn and the Antarctic circle, in which the water area is approximately twelve times as great as that of the land. Consequently, although the location of this land amidst so much water offers man relatively favorable climatic conditions, yet its limited area includes only about two per cent of the world's population. Part of the reason for the relatively small population in this part of the Southern Hemisphere is, however, due to its isolation, another locational factor.

The population map, Figs. 1 and 2, shows that population is extremely sparse in the regions within the polar circles. But the belt between the two tropical circles shows a number of areas with relatively dense populations. The water area of this belt is about four times that of the land; nevertheless, this belt contains about a third of all the land in the world and supports nearly a third of the world's population.

Population and land masses.—Since people live chiefly on land, the distribution of the world's population must necessarily be very closely related to the great land masses of the earth—their size, their shape, and their proximity to, or isolation from, one another. These great land masses are known as *continents*. The largest one of all is Eurasia. It lies entirely in the northern hemisphere and for the most part north of the tropic of Cancer. Eurasia contains a total of 20,936,000 square miles, or approximately two-fifths of the world's land area; and it supports an even larger proportion of the world's population, as its population is 1,390,000,000 out of a total for the world of 1,850,000,000. That is, some three-fourths of the world's people here live on two-fifths of the land of the earth.

The next continent in size, though not in population, is Africa, which lies in close proximity to Eurasia. Its 11,515,000 square miles support about 138,000,000 people. On the other hand, contrasted with Eurasia both in size and population, is Australia, it being the smallest continent and having the smallest population. It lies wholly within the Southern Hemisphere, and its small population of 6,000,000 is due in part to its isolation from the other continents.

Almost as close to Eurasia as is Africa comes North America, which lies entirely in the Northern Hemisphere. Its 9,323,000 square miles support a population of 156,000,000. The remaining continent occupied by man is South America, whose nearly 7,000,000 square miles contain some 65,000,000 people, or less than half the population of North America. Most of South America lies in the Southern Hemisphere. Almost entirely within the southern polar circle is another continent as yet largely unexplored. It is called Antarctica, and is without permanent human inhabitants.

The hemispheres.—Reference has already been made to the Northern and Southern Hemispheres. Many other ways of dividing the earth into hemispheres are possible. One method in common use is to divide the earth's surface by north and south lines into an Eastern and a Western Hemisphere. Lines extending from pole to pole on the earth's surface are known as *meridians*. The meridian passing through Greenwich, England, is usually considered the *prime meridian*. It is numbered zero (0°) and is another fundamental reference line, as the east or west location of places on the earth's surface is measured from the prime meridian (see Fig. 2). There are an infinite number of meridians, as is also true of parallels, but only a few of them are indicated on maps or globes. Both meridians and parallels are numbered in degrees, a degree

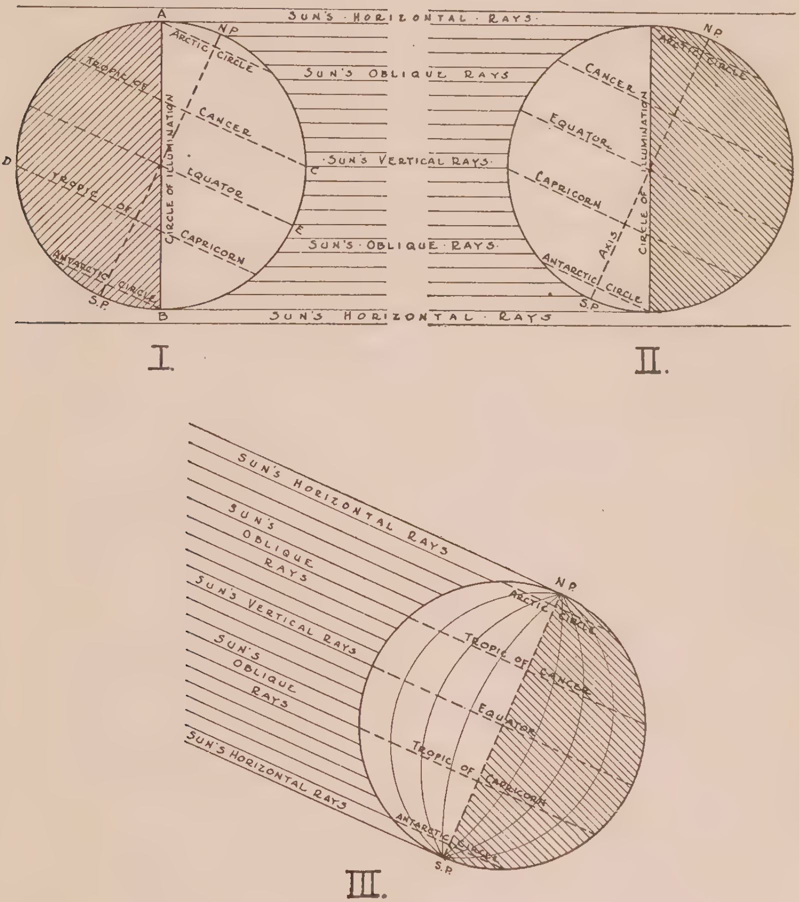


Fig. 14.

I. *Aphelian* position of the earth. June 21, *summer solstice.*
II. *Perihelian* position. December 22, *winter solstice.*
III. Position of the earth at the time of the *Equinoxes*, March 21 or September 22. At these times the sun's rays extend from pole to pole.

being 1/360 of the circumference of a circle. Just as any parallel is so many degrees north or south of the equator (numbered 0°), so any meridian is so many degrees east or west of the prime meridian.

Distances from the equator measured along a meridian are expressed as degrees of *latitude,* while distances from the prime meridian measured along a parallel are expressed as degrees of *longitude.* Since the meridians come together at the poles, and longitude is measured along the parallels between meridians, it follows that a degree of longitude is longest at the equator and gets shorter nearer the poles. This is evident from III, Fig. 14 because a degree of longitude is always 1/360 of a parallel and the parallels decrease in length from the equator to the poles.

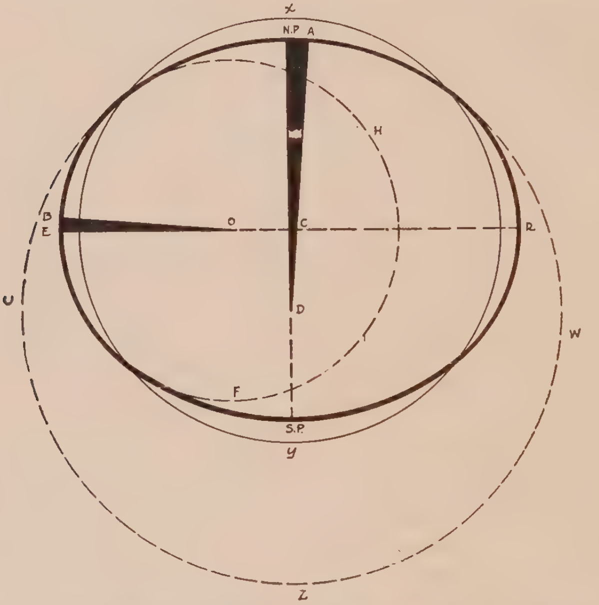


Fig. 15.—Why a degree of latitude is longer near the poles than near the equator. A cross section of the earth through the poles (see ellipse, heavy dark curve) differs from a true circle (xy) in being flattened at the poles (NP and SP) and bulged at the equator (E and R); hence an arc, NPA (part of a circle with center at D), is longer in miles than an arc, EB, (part of a circle with center at O), when the angles at O and D are equal.

The length of a degree of latitude, on the other hand, is longer near the poles than near the equator, because the earth is not a true sphere but an *oblate spheroid* slightly flattened at the poles. This results in the part of any meridian near the poles being the arc of a larger circle than is the part of the same meridian near the equator. Now a degree of latitude on any part of a meridian is 1/360 of the complete circle of which that part of the meridian is an arc. Thus in Fig. 15 a degree of latitude between NP and A is 1/360 of the circle NP-A-W-Z-U, while a degree of latitude between B and E is 1/360 of the circle B-E-F-H. Therefore, a degree of latitude near the poles is longer than a degree near the equator.

The meridian of 20° west longitude and the one of 160° east longitude divide the earth into the halves named above as the Eastern and Western Hemispheres. North and South America are practically all in the Western Hemisphere, while all the other inhabited continents are in the Eastern Hemisphere.

The marginal location of people.—Another locational aspect of the distribution of the world's population is the concentration of people along the margins of the continents, and the relative sparsity of population in the continental interiors. Thus Eurasia shows a density of 250 to 500 or more people per square mile along much of its eastern, southern, and western margins, while large areas of its interior have less than two inhabitants per square mile. And in South America probably 96 per cent of its population live within one hundred miles of the coast. Among the reasons for the greater density of continental population along the margins than in the interiors are the locational factors of position, distance, and accessibility.

Location and Man's Activities.

Economic activities.—Location is exceedingly important in all economic activities. Thus the *area* of the land cultivated by a farmer affects the type and methods of his agricultural practice and the quantity of his product. Labor, land, and other capital (such as live stock, machinery, seed, and fertilizer) are always combined to carry on agriculture. If the area of the land used is large in proportion to the amount of labor and other capital employed upon it, we have what is called *extensive utilization of land,* or extensive farming. On the other hand, if the amount of labor and other capital used is large in proportion to the quantity of land on which it is used, we have *intensive utilization of land,* or intensive farming. The more intensive the farming, the greater the product per acre is likely to be; whereas, in extensive farming, although there may be a smaller yield per acre, there is usually a larger product per capita or per man. As *area* thus affects the farmer's production, likewise *distance,* another locational factor, influences the marketing of his products. Thus, the distance of a market from his farm may so increase the cost of disposing of his products as to reduce materially his profits, or even to result in a loss.

In manufacturing, too, location is fundamental, inasmuch as such factors of plant location, as accessibility of raw material, nearness to a labor supply, proximity to the market, and availability of good and cheap transportation facilities, may be expected to contribute vitally to the success of the enterprise.

Other economic activities, such as fishing, mining, commerce, transportation and communication, are all related in one way or another to location. For instance, in transportation, distance is an important factor. Ordinarily, other things being equal, the shortest distance between the starting point and the destination of a trip, a voyage, or a shipment, is the most desirable route. For this reason ocean steamers follow as far as possible what are called "great circle routes." The equator, any two meridians which divide the earth into hemispheres, and any other circle which bisects the earth's surface are known as great circles. The shortest distance between any two points on the earth's surface is along the circumference of a great circle (see Figs. 16 and 26).

One way in which distance affects economic activities is in the matter of the *time* involved. Time enters the calculation in two principal ways. The greater the distance to be overcome, in transportation for example, the greater the amount of time required; and the more time consumed the more costs accumulate in the way of wages, interest, depreciation, and so forth. The other way in which time affects the proposition as related to location is that the time at any given place depends directly upon its distance or longitude east or west of the prime meridian.

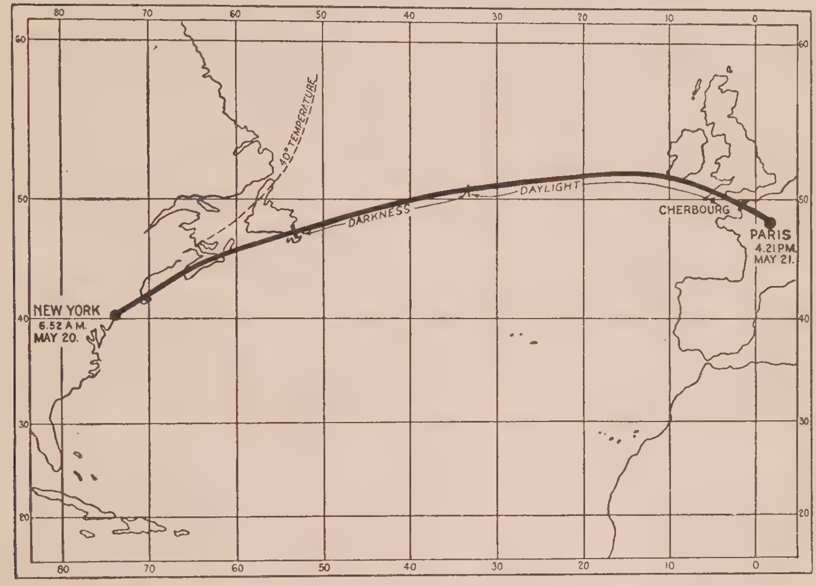


Fig. 16.—Showing approximate Great Circle route taken by Lindbergh. A straight line on this map from New York to Paris would not be the shortest route between these two cities.

Time as an Element of Location.

Longitude and time.—Since a circle or parallel is divided into 360° and the earth turns or rotates towards the east once every day of 24 hours, it follows that each hour it passes over 1/24 of 360° or 15° of longitude. Therefore, so far as the earth's rotation towards the east, or the apparent motion of the sun toward the west is concerned, two places 15° apart will have an hour's difference in time, the place farther west having the earlier time. Likewise, a difference of longitude of 90° between two places causes a difference of six hours in time; or, conversely, if one place has six hours earlier time than another, it is normally to be expected that the second place is 90° east of the first.

Standard time belts.—These differences in time at various places would result in much confusion in human affairs, such as railroad time-tables which give the time of arrival and departure of trains at many stations, were it not for the adoption of what is called standard time. This involves the use of the local mean time of the meridians 15°, 30°, 45°, and so forth, east and west of the prime meridian. In the United States, for example, the time of each of the four meridians 75°, 90°, 105°, 120°, W. long. constitutes the standard time of the Eastern, Central, Mountain, and Pacific Belts respectively, all places within each belt thus having time one hour earlier than the time of places within the belt next east of it (see Fig. 17).

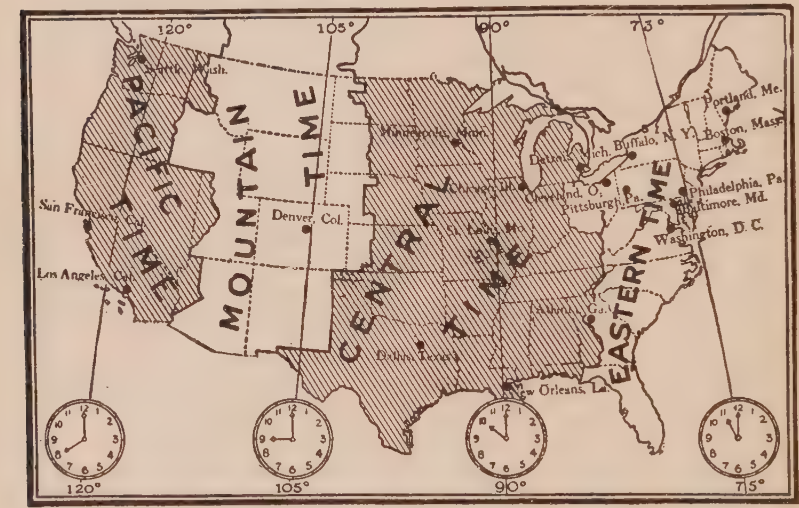


Fig. 17.—The standard time belts of the United States. The time of the meridian, marked in a belt or zone, is used as the standard time for all places in that belt.

International date line.—Since each 15° farther west means another hour earlier it would result that 360° farther west would mean 24 hours earlier, or a whole day earlier. But 360° brings one back to the starting point, and it being manifestly impossible to have to-day and yesterday at that point at the same time, it became necessary to settle upon some point or line at which the day should change or the new day begin.

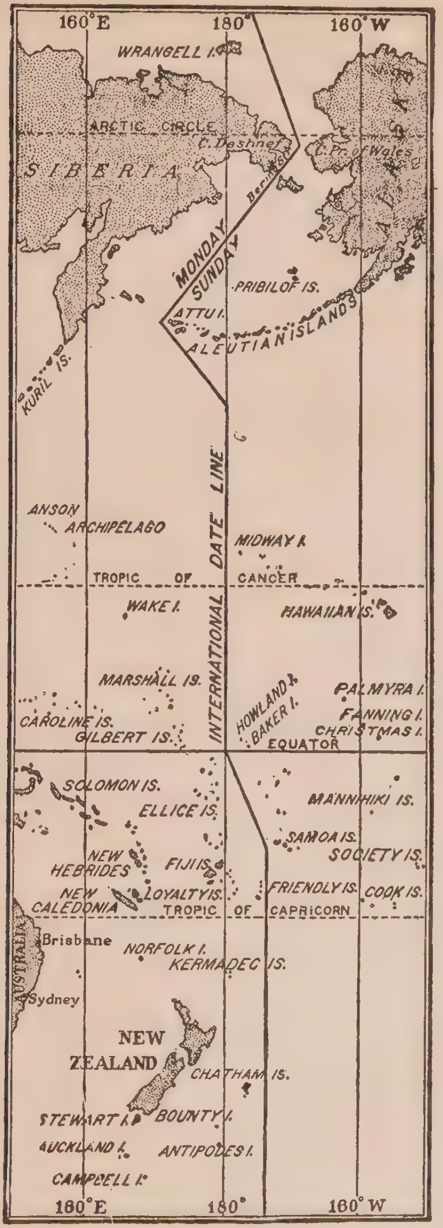


Fig. 18.—The International Date Line, at which each new day begins. Since this line moves eastward along with the earth as it rotates, it *leads* the new day, which is therefore *following* the date line, that is, just to the west of it.

This line, agreed upon by the leading nations of the world, is known as the *international date line* (see Fig. 18). The line adopted was the meridian of 180°, with the exception of two or three places where the line is crooked to prevent its passing through populated places which would result in confusion. Ships crossing the international date line from the west repeat a day in their calendar, while those crossing it towards the west drop out a day.

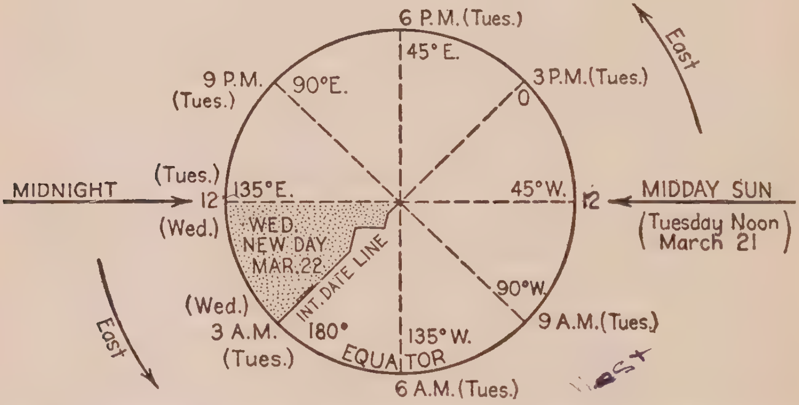


Fig. 19.—Diagram Illustrating How Two Lines (the international date line and the midnight line) Separate the Two Days on the Earth.

This change in time may be better understood if an analysis of Figure 19 is carefully made. In this diagram the Northern Hemisphere is shown as viewed from the north pole. Meridians are drawn at intervals of forty-five degrees. The midday sun for Tuesday, March 21, is directly over the 45° meridian (W. long.). Directly opposite the midday sun, on the other side of the earth, is midnight (135° E. long.).

Since a new day always starts at midnight, the question arose as to where it should begin first. So it was established by international agreement that this new day should start first at the international date line whenever this line passed the midnight position. This new day is Wednesday, according to this diagram.

We then have Wednesday in all parts of the earth from the international date line west to 135° East longitude, which is the midnight point at this time. The rest of the world has Tuesday. If the international date line were at the midnight point, and it were Tuesday at the midday point, then it would be Tuesday all over the earth; but that is not the case, as shown in this diagram. The international date line has rotated eastward with the earth a distance of 45° from the midnight point. Thus, this distance of 45° is having Wednesday, the new day. While the earth rotates in an eastward direction, the portion of the earth which has Wednesday becomes greater, until finally it is Wednesday in all parts of the earth. Then, as the international date line passes the midnight position again, another day is born, Thursday, and so the cycle of time continues to turn.

Thus, the two days usually on the earth at the same time are separated from each other by two lines: (1) the midnight line, which *stays* opposite the noonday sun; and (2) the *moving* international date line, just west of which is the new (later) day.

Business and the calendar.—Webster says a calendar is an orderly arrangement of the divisions of time, as days, months, and years, adapted to civil life. It may be a record of time, but not exactly an orderly arrangement of this time, as exemplified by the present calendar system. One is not sure, until he looks at the calendar, on what day of the week the month begins, nor on what day a certain date falls.

There is a movement to improve and simplify our calendar. The new calendar, as proposed by the Cotsworth International Fixed Calendar Association, would have every month like every other month, all having twenty-eight days, and all beginning on Sunday and ending on Saturday. Each month would have exactly four weeks of seven days each. As each month, except February, would thereby lose a few days, it would be necessary to add another month (to be called " Sol "), which would be placed between June and July, as at that time of the year the change would cause the least confusion with respect to the seasons. A 365th day would be added as December 29, but it would never be a week day. This day would be inserted as an extra Sabbath between Saturday, December 28 and Sunday, January 1, and would be called Year Day. Every fourth year the additional day which is now given to February would be inserted between June and the new month "Sol," as an additional Sabbath.

Some of the suggested advantages of this change are: every Sunday of every month of every year will be either the first, the eighth, the fifteenth, or the twenty-second, and so with the other days of the week; the nineteenth, for instance, will always mean the third Thursday; one can calculate instantly the exact day of payments to be made; one will not be paying rent at the rate of more per day in some months than in others. In business the inconvenience of having some months of four weeks, and some of five, will be eliminated. Holidays will be fixed, and can by law become a week-end vacation period.

In some cases business houses have already adopted a twenty-eight-day month. While this may mean extra accounting for them, they nevertheless find the saving pays for the trouble. An instance of this is briefly discussed in the following quotation from the *Industrial Digest:* "In the case of the Eastman Kodak Company we have adopted the thirteen-period calendar for all factory records and accounts beginning January 1, 1928. The chief benefit to be obtained is that all periods will be comparable without any adjustment being made for the unequal number of days and the unequal number of weeks. No adjustment will be necessary in the factory cost, burden, and productions reports; the splitting of payrolls will be unnecessary; the burden reports will be comparable for different periods of the same and for corresponding periods of different years without any adjustment. Of course, there will be a slight additional expense involved in making thirteen statements a year instead of twelve, but the saving due to the elimination of adjustments will far outweigh this item."

Location and political activities.—When in the lower stages of human culture, such as the hunting and fishing communities of the savage stage, the pastoral nomads of barbarism, or even the half civilization of primitive agriculture.

people tend to occupy *scattered* locations. The groups are generally small and detached, for their methods of utilizing the land and other natural resources are, as a rule, not economical, and, consequently, relatively large areas are needed to support even small population groups. Thus, when the Europeans first came to North America they found the vast region occupied by Indians who lived and hunted in widely scattered regions. Even in the case of the Iroquois " Nations " of New York and the Lower Lake regions, perhaps the most advanced and best-organized Indians east of the Mississippi, we find that at least one of their groups, the Tuscaroras, occupied a position as detached as the southern end of the Appalachians in North Carolina. Among primitive peoples in general, scattered location is the normal condition.

In all stages of civilization, however, scattered location results whenever one people expands or encroaches upon another race until it begins to appropriate the invaded territory. One theory of the origin of the state is that it grew out of the political control forced upon such defeated peoples by the victorious groups, who proceeded to establish themselves in strategic locations from which they could rule the land and exact tribute from the vanquished race. At any rate, invasion and conquest have usually resulted in political control enforced at first from scattered and strategic locations. Such, for example, was the case of the invasion, conquest, and government of Mexico and South America by the Spanish in the fifteenth and sixteenth centuries.

The importance of location in political affairs is evidenced by the custom and desire of the leading nations of the world of having an assured *frontage upon the ocean* or upon one of its connecting seas. Thus we find England, France, Spain, Portugal, Brazil, and Argentina facing the Atlantic; Chile, Japan, and China upon the Pacific; Italy on the Mediterranean Sea; and Germany on both the Baltic and the North Seas. Russia, dissatisfied with her outlook upon the winter-frozen Baltic and the Arctic Ocean, and balked by the rival nations of western Europe in her attempt to get an outlet upon the Mediterranean Sea or the Indian Ocean, finally reached out thousands of miles across Siberia to secure a position upon the Pacific, where her efforts to get an ice-free port led to her unsuccessful war with Japan in 1904.

Location as a factor in political geography is also illustrated in the *strategic positions of the capitals* of states and nations, as, Columbus in central Ohio and Moscow in central Russia, or Washington on the Potomac and London on the Thames. Its importance is seen, too, in *boundary disputes* such as that between Pennsylvania and Maryland which resulted in the "Mason and Dixon Line" and that between Ohio and Michigan which resulted in the "Toledo War," or such as those between Bolivia and Paraguay, and between Chile and Peru, which for years were a source of political trouble in South America.

Location in military and historical geography.—In military geography strategic positions are often the key to success in military and naval operations. In the Old French and Indian War between the English and the French for the possession of North America the "Forks of the Ohio" where Pittsburgh now stands was a key-position desired, and bitterly fought for, by both sides. In our Civil War the strategic position of Vicksburg had to be taken before the Mississippi could be opened, thus cutting the South in two. In the recent Great World War the position of Belgium between Germany and what she thought the vulnerable part of France led to the invasion by Germany of Belgium, a neutral country; and the position of Germany on both the Baltic and the North Seas, connected by the Kiel ship canal, made it difficult for the Allies to bottle up the German fleet, even with superior numbers.

These are also examples of locational influences in historical geography. Others might be cited throughout all history, ancient or modern. Thus, the position of Egypt in the fertile Nile valley, protected by deserts on two sides and the Mediterranean Sea on another, permitted the development of one of the world's earliest civilizations. The location of little Phœnicia on the eastern margin of the Mediterranean, at the meeting point of Asia, Africa, and Europe, allowed that little country to become a trading and colonizing nation of a fame, success, and importance exceedingly great in proportion to the size of its territory or its population. The advantages of a peninsular position, particularly in the early development of a nation, are illustrated in the histories of Greece, Rome, Spain, Portugal, and Scandinavia. Modern England and Japan owe much of their success to their insular location. While of our own country, Miss Ellen Semple, one of our foremost social geographers, says: "The most important geographical fact in the past history of the United States has been their location on the Atlantic opposite Europe; and the most important geographical fact in lending a distinctive character to their future history will probably be their location on the Pacific opposite Asia."

CHAPTER V

MAPS AND THEIR INTERPRETATION

Maps as Records of Location.

Definition of a map.—A map is a graphic representation of the earth or some part of the earth. It is of basic importance in all geographic study. Professor J. Paul Goode, our foremost American cartographer, says, " A map is a written language expressed in a system of shorthand, and one that can be easily understood."

Utilization of maps.—The pictorial character of maps, the brevity of expression on maps, and the value of the information represented on maps have made them an indispensable part of the equipment of every progressive home, school, and business institution.

The *pictorial* aspect of maps is of vital significance. It has a psychological effect in attracting attention, maintaining an interest, and producing an impression which the mind will carry long after written or spoken words are forgotten. A place definitely located on a map is not so easily forgotten. The business man appreciates the visible advantages of maps in advertising his products. The information which people in general have about the earth's surface has been obtained from maps. It may be correct or erroneous, depending largely upon the type of map used as a source of information.

Brevity is another valuable attribute of maps. A carefully selected and applied method of graphic representation may guard against needless waste of time, energy, and material. At present it is almost impossible to glance through textbooks, newspapers, current magazines, books of travel, and even occasional novels, without seeing maps of one sort or another. This illustrates the importance that authors and editors place on maps as a means of conveying ideas which could otherwise be conveyed only by pages of description.

Maps are valuable not only as a means of conveying ideas in a concise and graphic form, but they also serve as an indispensable *source of information* which cannot always be successfully expressed in words. The representation of anticipated or proposed projects, the recording of new facts from experiments or explorations, the location of transportation and communication lines, and the plotting of distribution factors are a few of the countless examples of progress that maps can express by various ingenious methods.

Maps play an important part in *business*. Professor Eugene Van Cleef of Ohio State University says, "Maps save words, reveal direct information, emphasize relative and comparative situations, attract interest, and bring to life facts hidden in unplotted data. When we use them to the limit we shall have progressed far in our goal towards successful business efficiency." The average business man has learned to recognize some of these valuable characteristics of maps. Helen Strong, cartographer for the United States Department of Commerce has stated that "the general of an army would not think of laying out an important campaign without maps, and business men are coming to the same point of view—they need a political or physical map showing towns and railroads. These may be used in marking out market areas, in plotting sales territories, and in indicating lines of expansion and distribution of salesmen or products. In studying a given situation practically every kind of map, in addition to the political or physical, may be used—climatic maps, topographic maps, maps of mineral resources, soil maps, population maps, and so on down the list."

Some of the requests that come to Miss Strong's office emphasize the importance of maps. "The manufacturer of oil-drilling machinery called upon to deliver it to an unknown place in the interior of Venezuela wants a map showing the spot and the roads leading to it. One man may ask for a black-and-white base map; another wants details regarding the Belgian Congo; the Army Air Service may be searching for a map of South America to use in planning its flight around that continent; some one on the Pacific Coast may want a set of maps to fit into the window frames in his office; a firm of engineers in Texas needs maps and data regarding the inland waterways along the Gulf of Mexico; others need topographic sheets to use in planning sales and developing certain market areas. Without the map as a tool and a background these men would be without guide, as is a motorist who goes hit or miss in a strange country and is lost."

Classification of maps.—The bases for the classification of maps are numerous and not always clearly defined. A broad grouping, one that has met some approval, involves the classification of maps into: first, a class of maps which concern a large area, and consider the curvature of the earth's surface; and, second, maps of small areas, which do not necessitate a consideration of the earth's spheroid form. Another classification deals with: first, physical maps; and second, nonphysical or flat maps. A third method is based upon the purpose of the map. The major groups in this classification are presented in brief. The number of subdivisions is nearly unlimited, so only a few are listed. There are also other major divisions which have not been included. The recorded groups involve primarily those which are of general value:

PARTIAL LIST OF MAPS CLASSIFIED AS TO PURPOSE

- Physical:
  - Geologic
  - Relief
  - Soil
  - Weather and Climate
- Historical:
  - Ancient
  - Medieval
  - Modern
- Economic:
  - Industrial
  - Agricultural
  - Commercial
  - Mining
  - Railroad
  - Traction
  - Automobile
  - Aviation
  - Road
  - Telephone, Telegraph, and Cable
- Political:
  - Population
  - Countries
  - States
  - Cities
  - Townships
  - Boundaries
- Military:
  - Outpost
  - Campaign
  - Range

Some maps are misleading.—Maps have often been given the name Ananias. Those who remember the story of Ananias and Sapphira will remember how they "held some back." Maps may also "hold something back" unless carefully interpreted.

An examination of a map constructed on the Mercator projection represents Greenland as being larger than South America, when, as a matter of fact, South America is nine times as large as Greenland. Suppose that a Russian map-maker desired to show the extent of Bolshevism in the world to-day. If he used a Mercator map, and colored red all regions under the sway of Bolshevism, the map would make apparent an alarming situation—that almost half the world's area was under Russian influence. This exaggeration of thought expressed by the map is due to the method of projection and interpretation.

An improper use of the scale of a map may be equally responsible for misconceptions. If the scale of the map is not the same in all parts it should be known, in order to make the necessary correction. Many of the maps issued by transportation companies change the scale of the map, in order to place undue emphasis on the view which they desire to convey to the public. A recent map of one of the Great-Lakes lines represents the Lakes as comprising an area greater than all land in the United States east of the Mississippi and north of the Ohio River. This apparently increases the length of the voyage which may have an advertising value, but a false one. The map-makers of railroad routes have sometimes been called distortionists because they use every means of graphic misrepresentation to make a certain route seem direct and most advantageous.

The composition of two maps of different scales may prove disastrous. The tendency is to have a small-scale map of the United States and a large-scale map of Europe or South America. Such a comparison cannot prove successful. The study of extensive areas as represented by a large-scale map may also be misleading. It is the common belief that Africa has no rivers except the four or five large ones—an erroneous idea resulting from the use of large-scale maps.

The type of symbols or methods of coloring, accompanied by skilled workmanship, may be another means of misleading the reader. A dark red color over a small area may be more effective than a light red color over a large area. The use of heavy shading may place the emphasis on the wrong factor. These erroneous factors of maps demand a considerable degree of attention in order to guard against their fallacy.

An ideal map.—An ideal map should have one purpose, represented in a simple, legible, accurate, and beautiful form. All areas should have their true shape; they should retain their relative sizes; and the distance of every place from every other should bear a constant ratio to the true distance upon the earth. These properties can be represented on the globe, but are not easily secured on a flat map, and never all on the same map.

The globe, a miniature of the earth.—A globe is a true representation of the earth. It is a source of accurate ideas regarding the shape, size, and position of the earth's features. Formerly, the globe was of far greater practical importance than it is to-day. Now for the most part globes are " dusty " and " relegated to the position of an ornamental accessory in libraries and classrooms." This unfortunate condition can be accounted for largely by the great improvement that has taken place in the production of wall maps and atlases. Their excellence in the representation of details and their cheapness have contributed to their universal use, while the greater cost and difficulty of using globes are reasons for their limitations.

Although a globe may not meet the practicability of maps, it has many *advantages* over the flat maps in showing, without distortion, the true shape, size, and position of the earth's major surface features, such as the continents and the oceans. The shape of the globe is similar, and in proportion to, the form of the earth. The motions of the earth can be successfully illustrated with a globe. Thus, study of location is greatly facilitated with the aid of a globe.

Map Projection.

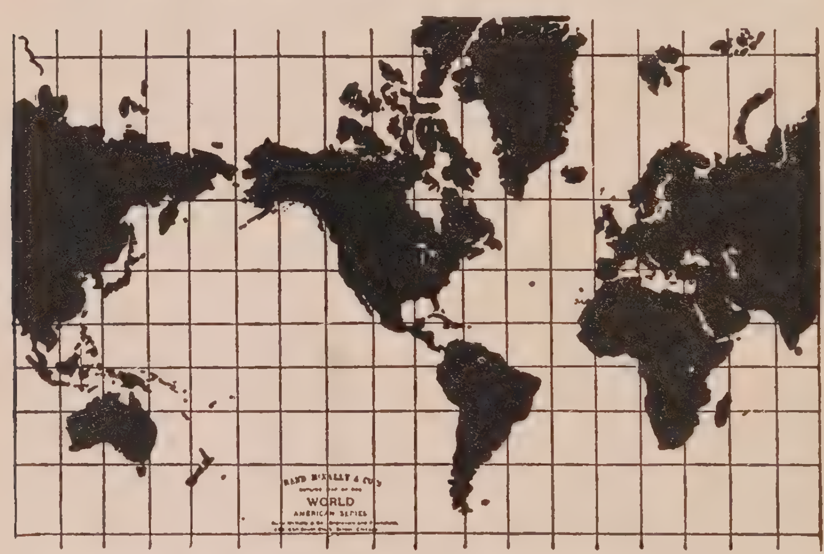
Map transition.—Map projection or transition may be defined as " a systematic drawing of parallels and meridians for the whole earth, or some portion of it, on a plane surface." In the representation of the curved surface of the earth or any portion of it, on a plane surface, a considerable amount of difficulty is encountered because no portion of the surface of a sphere or spheroid can be spread out in a plane without some stretching or tearing. This can be seen by attempting to flatten out a cap of orange peel or a portion of a hollow rubber ball; the outer part must be stretched or torn, or both, before the central part will come into the plane with the outer part. This is exactly the difficulty that has to be contended with in map making.

There are some curved surfaces, however, that can be spread out into a plane without stretching or tearing. Such surfaces are called developable surfaces, and include such as the surfaces of a cone or cylinder, while those like the globe are called undevelopable. If a cone of revolution, or a right circular cone as it is called, is formed of thin material-like paper, and if it is cut from the base to the apex, the conical surface can be spread out in a plane with no stretching or tearing. Any curve drawn on the surface will have exactly the same length after development that it had before. In the same way, if a cylinder surface is cut from base to base, the whole surface can be rolled out in the form of a plane without any distortion. The Mercator projection is constructed on this principle.

Mercator projection.—One of the most valuable events of the sixteenth century was the invention of the Mercator projection. It was perfected by Gerard Kremer, which name, meaning merchant, was latinized in accordance with the custom of the time, into Mercator. It is possible that Mercator, being a globe-maker, devised his map in the following way: He probably removed the gores from a globe by cutting them along the meridians, but did not quite cut the gores in two across the equator. When he removed the map, he laid it down flat, which represented a plane surface. This was still inconvenient, for the map showed hiatuses, or vacant spaces, between the gores. To eliminate these hiatuses, he joined the gores along the meridians. He discovered that he had introduced exaggeration into his projection, which increased as the polar regions were reached, owing to fact that the distance between the gores was greater as the poles were reached.

In order to balance up his map, he introduced distortion in latitude as he had distorted longitude. The result was that he restored somewhat the balance of the map as to shape.

The Mercator method may also be demonstrated by imagining a cylinder (a developable surface) placed over a globe. Then let straight lines be drawn from the center of the globe through points on its parallels and meridians, and projected until they touch the cylinder. Then the cylinder is cut from base to top and opened out into a plane. It will have a grill of parallels and meridians which are straight lines and perpendicular to each other. Every parallel is shown as having the same length as the equator, and the meridians are elongated in proportion to the parallels.



Adapted from map of Rand, McNally & Co.

Fig. 20.—Mercator's Projection of the World.

Thus the parallel of 60° north or south is, on a globe, half as long as the equator, but it is represented on the Mercator projection as the same length. Since the meridians are proportionately elongated, a place on the 60° parallel is drawn approximately four times its true size. Greenland appears as large as South America, when, in fact, South America is nine times as large as Greenland. These exaggerations in area can be offset in part by properly adjusting the scale of the map. It can be said that within 30° of the equator the Mercator projection does not offer serious exaggeration in area or shape (see Fig. 20).

The Mercator projection was primarily designed for the construction of nautical charts, and in this field has attained an importance beyond all others. The useful features of the Mercator projection in world maps have recently been well presented by Deitz and Adams of the *United States Coast and Geodetic Survey,* who say:

> Granted that on the Mercator projection, distances and areas appear to be distorted relatively when sections of the map differing in latitude are compared, an intelligent use of the marginal scale will determine these quantities with sufficient exactness for any given section. In many other projections the scale is not the same in all directions, the scale of a point depending upon the azimuth of a line.
>
> As proof of the impossibilities of a Mercator projection in world maps, the critics invariably cite the exaggeration of Greenland and the polar regions. In the consideration of the various evils of world maps, the polar regions are, after all, the best places to put the maximum distortion. Generally, our interests are centered between 65° north and 55° south latitude, and it is in this belt that other projections present difficulties in spherical relations, which in many instances are not readily expressed in analytic terms.
>
> The Mercator projection embodies all the properties of conformality, which implies true shape in restricted localities, and the crossing of all meridians and parallels at right angles, the same as on the globe. The cardinal directions, north and south, east and west, always point the same way, and remain parallel to the borders of the chart. For many purposes, as in meteorological charts, for instance, this property is of great importance. Charts having correct areas with cardinal directions running every possible way are undesirable.
>
> While other projections may contribute their portion in special properties from an educational standpoint, they cannot entirely displace the Mercator projection, which has stood the test for over three and a half centuries. It is the opinion of the authors that the Mercator projection, not only is a fixture for nautical charts but that it plays a definite part in giving us a continuous conformal mapping of the world.

Mollweide's homolographic projection.—This projection is one of the basic methods for the representation of the entire globe without serious distortion of area. It is known as an equal-surface projection, that is, a square inch upon the map in one place and a square inch in another place are equal in area. The equator and parallels are drawn proportional to those on a given globe, and are straight lines. The meridians divide the equator into equal parts, and converge at the poles. The central meridian is half as long as the equator, and is a straight line, whereas all others are curved. The whole map has the form of an ellipse.

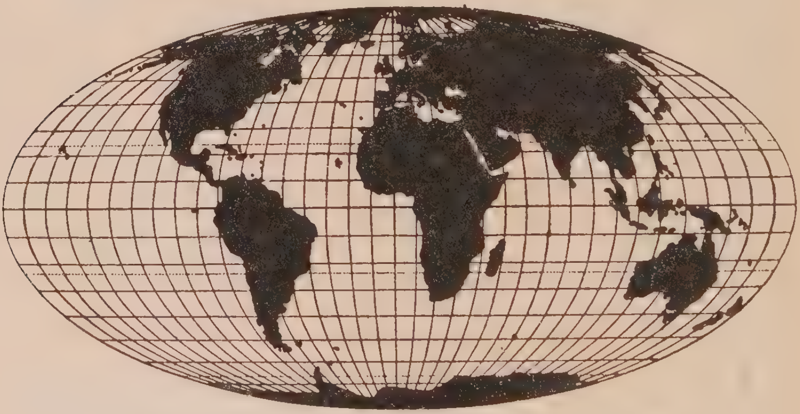


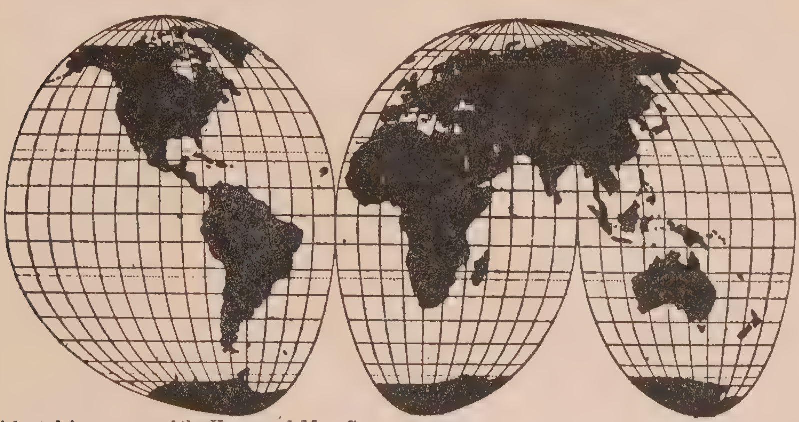
Fig. 21.—Mollweide's Elliptical Projection of the World.

Areas are equal all over the map, but the shape of continents is greatly distorted, and the distortion increases with distance from the central meridian. (See Fig. 21.)

The objectionable features of the homolographic projection have led to intensive research on the part of cartographers to improve the representation of the world on a single map. These efforts have resulted in the perfection of many valuable projections, among which, one, Goode's homolosine projection, is particularly outstanding.

Goode's irregular homolographic or homolosine projection. This is an equal-area projection, accurate to scale within 40° of the equator. Each continent is drawn on a separate central meridian, so that no part of the map is far enough from a center to be seriously distorted. It is pointed out in Mollweide's projection, of which Goode's projection is a modification, that distortion of shapes increases with distance from the central meridian.

Thus, with a central meridian for each continent, the distortion of an area is reduced. The use of several centers has been made possible by interrupting the continuity of the projection, in oceans if land is to be emphasized, and in continents if continuity of oceans is desired.



Adapted from maps of the Hammond Map Company.

Fig. 22.—Goode's Homolosine Equal-Area Projection.

In the Mercator and Mollweide's projections this adjustment is not made, therefore necessitating stretching of the surface, which introduces exaggeration and distortion of land and water areas.

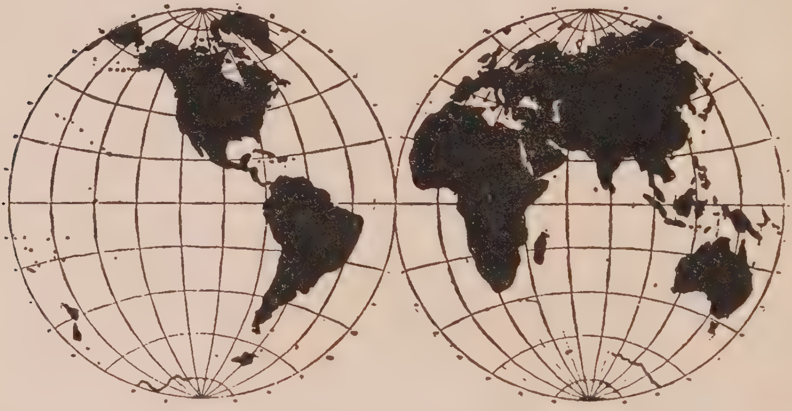
The equator in Goode's projection is divided into equal parts, and the meridians are curved lines, conforming to the nature of the interruption of the map's continuity. The parallels are straight lines. The latitudes above 40° are drawn on a different scale from that used for latitudes below 40°, thus further reducing the distortion of shape. (See Fig. 22.)

Other favorable projections which show world areas are: Aitoff's equal-area projection, Gugou's doubly periodic projection of the spheres, Van der Grinten's projection, Denoyer's homolographic projection, Cahill's butterfly projection and

Lambert's equal-area projection of the Northern and Southern Hemispheres.

Hemispherical projections.—The principle of these projections consists in the direct projections of the points of the earth by straight lines drawn through them from some given point. The primary projections of this group are orthographic, stereographic, globular, gnomonic, and Lambert's azimuthal.

In the *orthographic projection* it is assumed that the observer's eye is at a very great distance away from the earth and on the same side of the earth as the plane of the map projection. The parallels and meridians are projected toward the observer. The meridians and parallels are farther apart toward the center of the map. This projection is the representation of the globe as a photograph would show it from a great distance. This projection is accurate at the center, but at the margins the distances are greatly shortened.

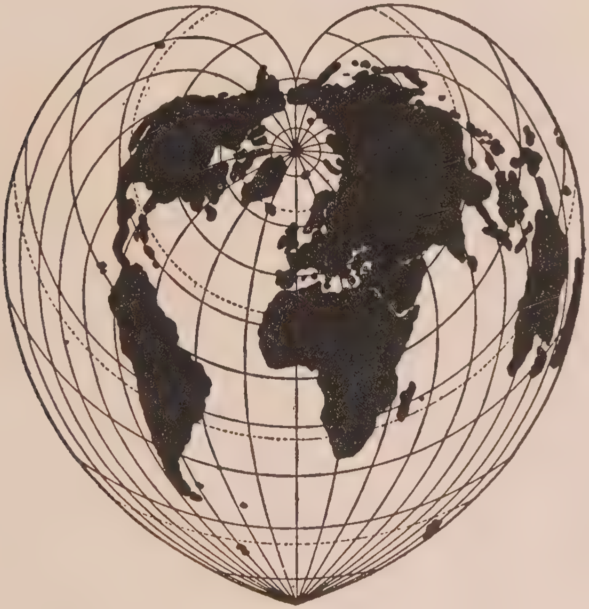


Adapted from Maps of Rand McNally & Co,

Fig. 23.—Hemispherical Projection of the World.

The *stereographic projection* is constructed in the same manner as the orthographic, except that the eye of the observer is conceived to be at the surface of the earth, and viewing the opposite hemisphere. This projection makes the center of the map too small, but the margins are more accurate or equidistant.

In the *globular projection* the eye of the observer is placed at a definite distance from one side of the earth, and at the level of the equator. The plane of projection is tangent to the equator on the other side from the observer. The parallels and meridians are projected on the tangent plane as the observer sees them by looking through the earth to the opposite side. It is an equidistant projection, because the meridians are equidistant along a given parallel, and the parallels are equidistant along a given meridian. This projection is then more accurate than either the orthographic or stereographic projections.



From Bartholomew's Atlas.

Fig. 24.—Heart-shaped Map of the World.

In the *gnomonic projection* the observer's eye is conceived to be at the center of the earth. The parallels are so far apart away from the center of the map that the gnomonic projection is almost never made with any other point than the pole for center, and then for latitudes about forty degrees from the pole. The polar gnomonic projection is of utmost value in navigation, as a great circle is a straight line. Each one of the hemispherical projections may be constructed to show the polar areas, or having the pole as a center rather than the equator.

Lambert's azimuthal is an equal-area projection. The surface to be mapped is deployed upon a plane tangent at the center of the area chosen. Points are placed correctly, according to their azimuths or bearings from the center of the map. This projection gives best shape to areas of continental size. It is especially good for polar hemispheres. There is distortion towards the edges farthest away from the center. Lambert's equal-area projection is one of the best hemispherical projections, and one that is used a great deal to show the Eastern and Western Hemispheres. (See Fig. 23.)

Conic projection.—The conic projection may be constructed with the use of a developable surface, that of a cone. A cone is placed so that it touches the parallel which runs through the center of the district to be mapped. Then straight lines are imagined drawn from the center of the globe through various points on its parallels and meridians, and extended until they intersect the cone. Then the cone is cut open from the apex to its base and flattened out, the parallels being curved lines, while the meridians are radiating straight lines. (see Fig. 4).

Along the parallel tangent to the cone, points on the map will correspond exactly to points upon the globe. Parallels which are near the line of tangency will be represented very much in the relative positions they occupy on the globe. Therefore, near the tangent parallel, there will be very little distortion in latitudes and longitudes, and an area mapped within this zone will be very similar in form and area to the form and area as it appears upon the globe itself. For this reason the conic projection, or some modification of it, is usually selected for representing small areas of the earth's surface. Thus the *polyconic* projection is used for the topographic sheets of the United States, published by the *United States Geological Survey.* Probably the two most important conical projections are the Lambert conformal conical projection and Alber's equal-area conical projection.

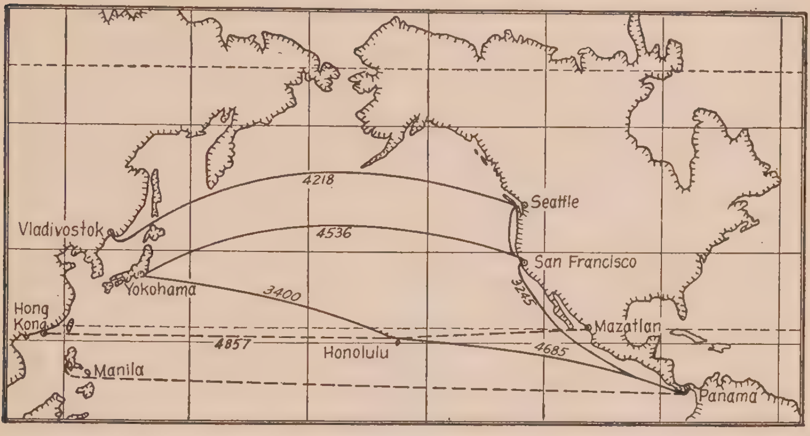


Fig. 25.—North Pacific trade routes and distances on a Mercator map. Honolulu *appears* to be on a direct line from Panama to Yokohama, or from Mazatlan to Hong Kong; while the shortest line from Panama to Manila *seems* to pass south of Honolulu. But these appearances are deceptive. (See Fig. 26.)

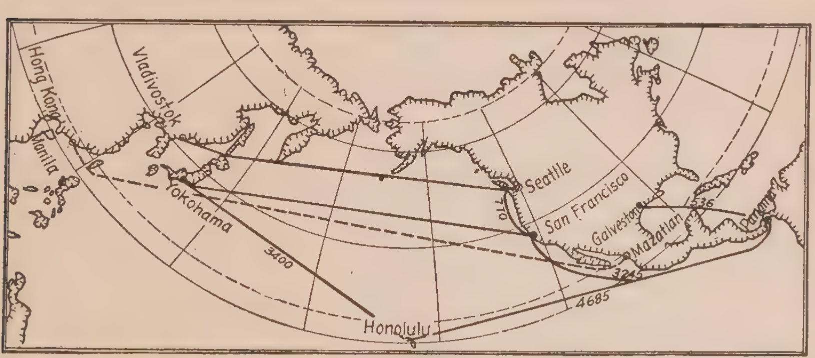


Fig. 26.—North Pacific trade routes and distances on a map drawn on a Butterfly projection. Here the shortest distances are straight lines, as on a globe, for they are great circle routes. Note that to go from Panama to Yokohama by San Francisco is shorter than by Honolulu. (Add the mileage in Fig. 25.)

The choice of a projection.—The selection of a projection should be governed by the purpose of the map. Since it is desirable to have all maps correct in shape, size, and direction, and since no one system of projection fulfills all of these conditions, it follows that we must decide whether we want: (1)

to maintain the shape of an area at the expense of its size, or (2) to retain a correct size at the expense of shape, or (3) to compromise between shape and size, so as to reduce to a minimum the errors of both shape and size, or (4) to preserve the correct directions of all lines drawn from the center of the map. This last factor is of great importance to navigators and aviators.

The difference in the appearance of trade routes on maps of two different projections is shown in Figs. 25 and 26. Thus on the Mercator map (Fig. 25) Honolulu appears to be on the direct line from Panama to Yokohama. But in fact, it would be much nearer to go by San Francisco. (See Fig. 26.)

Scale of Maps.

Horizontal scale.—The scale of a map is the ratio of a given distance, as represented on the map, to the same distance on the surface of the earth. Scales are of three common types; the graphic, the fractional, the verbal. The graphic is a line on the map marked off into units representing miles. The fractional is a ratio in the form of a fraction between a distance represented on the map and that distance on the earth's surface. As a formula it would be in the case of a map, for example, with the scale of an inch to the mile:

$$\frac{\text{Distance represented on the map in inches}}{\text{Corresponding distance on the earth in inches}} = \frac{1}{63{,}360}$$

There are 63,360 inches in a mile, but this fraction is very inconvenient to work with so 62,500 is more commonly used. Most maps show the fraction 1/62,500 which means that one inch on the map equals about one mile on the ground. The verbal scale is expressed as " an inch to the mile " or " an inch to two miles." This is not so accurate as the first two, hence it is not so frequently used. However, to insure some degree of accuracy, the distance on the map is always mentioned first.

The terms " small scale " and " large scale " are often misleading. A small scale means that the fractional scale is small. For example, a scale of 1 : 2,500,000 or nearly four miles to an inch, which is four linear miles on the ground as represented by one linear inch on the map, is small in comparison to

1 : 125,000, or about two miles to an inch. A still larger scale is 1 : 62,500, or about a mile to an inch. For maps of large areas we use a small scale; and for maps of small areas, a map of a larger scale may be used.

Vertical scale.—The ratio between the elevation in the field and that represented on a map is called the vertical scale. For example, one inch on a map equals 5000 inches of elevation in the field. The horizontal scale and the vertical scale should be as nearly as possible in true proportions.

Map Representation—Relief.

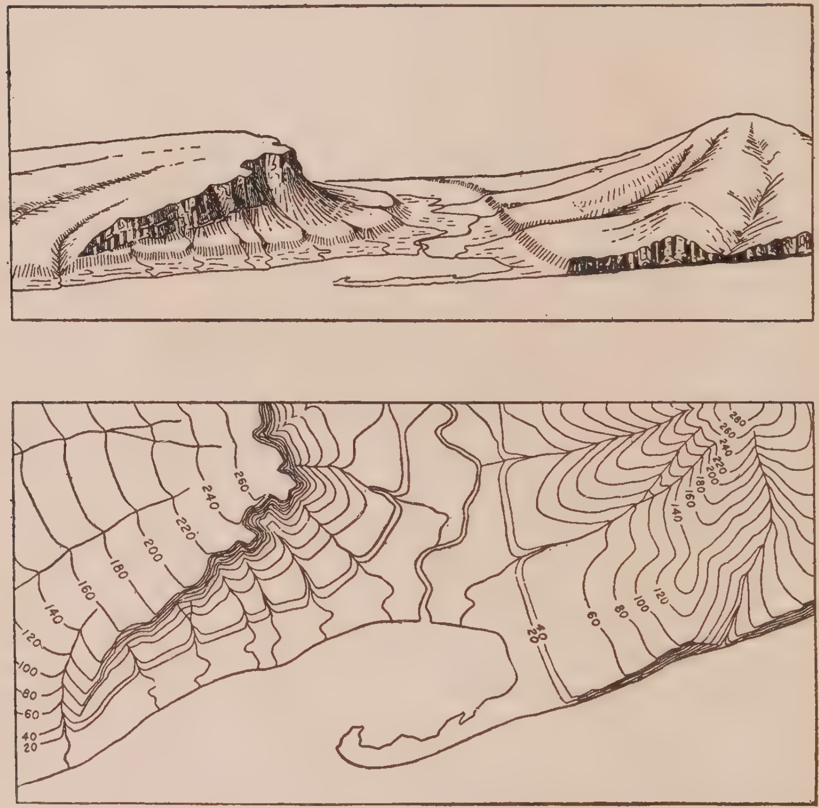
Color scheme.—The color scheme is one of the most impressive means of showing relief on maps. It fulfills the first principle of map making, namely, that a chart or map should be self-explanatory. This is one reason why the color method is used to represent relief on wall maps and on maps in elementary texts. It is easily understood.

In the use of the color scheme care should be exercised to use such colors as are attractive and a contrast to each other. The general tendency is to employ green for lowlands, maroon for highlands, and brown for land of intermediate elevations.

The color scheme is used primarily for the representation of the general relief of a large area, such as a continent or a country. The detailed variations in the relief cannot be successfully reproduced with the color scheme. Other methods are used for an accurate and minute study of the topographic or relief features.

The hachure method.—The hachure method includes the representation of relief by shaded lines. The nature of the slope is indicated by the thickening and spacing of the individual hachure lines. For example, a steep slope is shown by heavy lines, drawn very closely together; a gentle slope is lightly shaded; and a level surface is left unshaded. (See Fig. 27.)

The hachure method shows the shape and relative height of the land form, in which respect it is superior to the color scheme. But like the color scheme it is used to show only the general, or major, relief features. Frequently the color scheme is combined with the hachure method with results that are more satisfactory than those obtained by either method alone. In Europe, and especially in Germany, the colored hachure map has reached its greatest development.

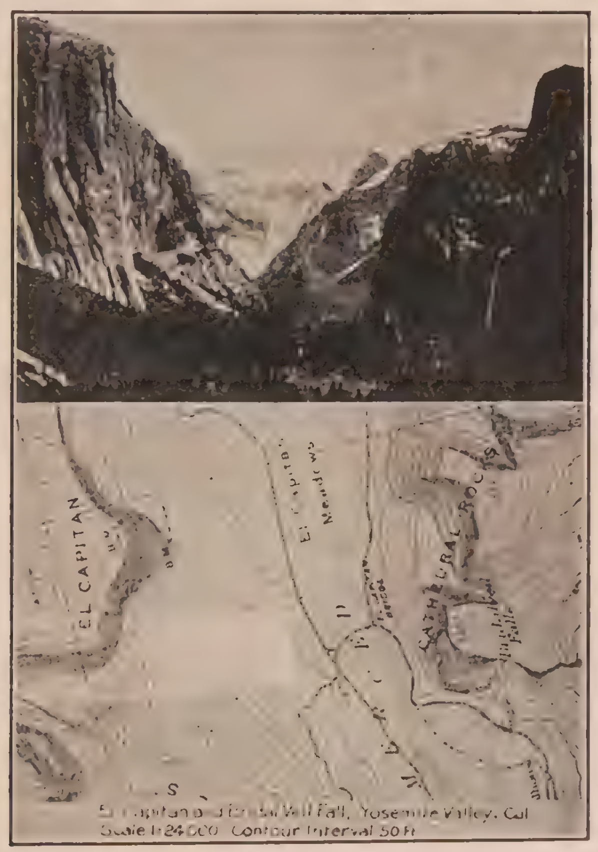


From topographic sheet of U. S. Geol. Survey.

Fig. 27.—The Relief of a given Land Area Shown by the Hachure Method (above) and the Contour Method (below).

Contour system.—The most accurate method of representing relief on maps is by means of contour lines. They show the true size, shape, slope, and height of the lands.

A contour line passes through points of the same altitude. "One who follows a contour on the ground will go neither uphill nor downhill, but on a level. By the use of contours not only are the shapes of the plains, hills, and mountains shown, but also the elevation. The line of the seacoast itself is a contour line, and datum or zero of elevation being mean sea level. The contour line at, say 20 feet above sea level, is the line that would be the seacoast if the sea were to rise or the land to sink 20 feet. Such a line runs back up the valleys, and forward around the points of hills and spurs. On a gentle slope this contour line is far from the present coastline, while on a steep slope it is near it. Thus a succession of these contour lines far apart on the map indicates a gentle slope; if close together, a steep slope; and if the contours run together in one line, as if each were vertically under the one above it, they


EL CAPITAN
El Capitan Meadow
CATHEDRAL ROCKS
El Capitan and Bridal Veil Fall, Yosemite Valley, Cal
Scale 1:24000 Contour Interval 50 Ft

Courtesy of U. S. Geological Survey.

Fig. 28.—Relief Representation by Photograph and Contour Map.

indicate a cliff. In many parts of the country are depressions or hollows with no outlets. The contours, of course, surround these, just as they surround hills. Those small hollows known as "sinks" are usually indicated by hachures or short dashes, on the inside of the curve.[1]

"The *contour interval,* or the vertical distance in feet between one contour and the next, is always stated at the bottom of each map. This interval differs according to the character of the area mapped; in a flat country it may be as small as five feet; in a mountainous region it may be 250 feet. Certain contour lines—every fourth or fifth one—are made heavier than the others and are accompanied by figures stating the elevation above sea level or datum. The heights of many points, such as road corners, summits, surfaces of lakes, and bench marks, are also given on the map in figures."

The contour map has a greater number of special uses than any other relief map, and it may be well to enumerate some of these uses:

1. *Administrative uses.*—The contour map often serves as a guidance for the construction of water supply and sewage disposal systems, canals, railways, and public highways.

2. *Agricultural uses.*—The Departments of Agriculture and Forestry use these maps very extensively in determining which land should be irrigated, drained, or reforested. The prospective purchaser of a farm can tell more about the land and its surroundings from looking at a contour map than he can from any other source. It gives him a composite survey at a glance.

3. *Military uses.*—This is one of the most important uses of the contour map. It is essential to military success that the army be at the most strategic point, and this strategic point can be readily determined from an accurate contour map. The cavalry, artillery, signal, and engineer corps use these maps almost constantly in their work.

4. *Educational uses.*—Contour maps are widely used in schools and colleges, especially in connection with the study of geology, physiography, and geography.

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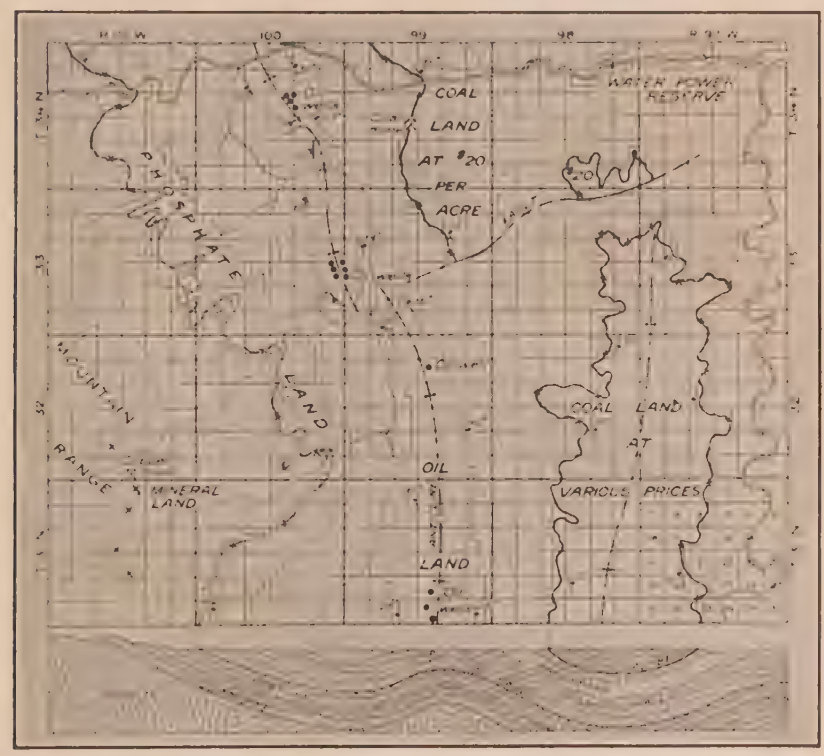
[1] United States Topographic Map.

5. *Industrial uses.*—These maps are of prime importance in aiding engineers in the placing of gas and oil lines, railroads, and waterpower projects at the most suitable places.

6. *Municipal uses.*—A city can use these maps to the best advantage in putting in streets, public parks, sewers and water supply systems, and also for many other similar purposes.



Courtesy of U. S. Geological Survey.

Fig. 29.—Map Showing by Range, Townships, and Sections, the Location of Waterpower Sites and Mineral Lands, together with Their Underground Structure.

7. *Travel uses.*—These maps are the finest of travel guides and they can tell us more about the physical conditions of the place in which we are traveling than any other map.

The relief model map.—The relief model method is a rather recent development in the representation of land forms on maps. It is based primarily upon the contour system and photography.

There are many ways in which relief model maps can be made, but the one derived from the contour system is most generally used. Pieces of cardboard are cut according to the shape of the contour lines. Then these pieces of cardboard are arranged one on top of the other in the same way as the contour lines appear on the map. Modelling clay is placed over the cardboards, and smoothened to conform to the land as it appears in the field. After the model is finished a photograph is taken and later printed on charts which are called relief model maps.

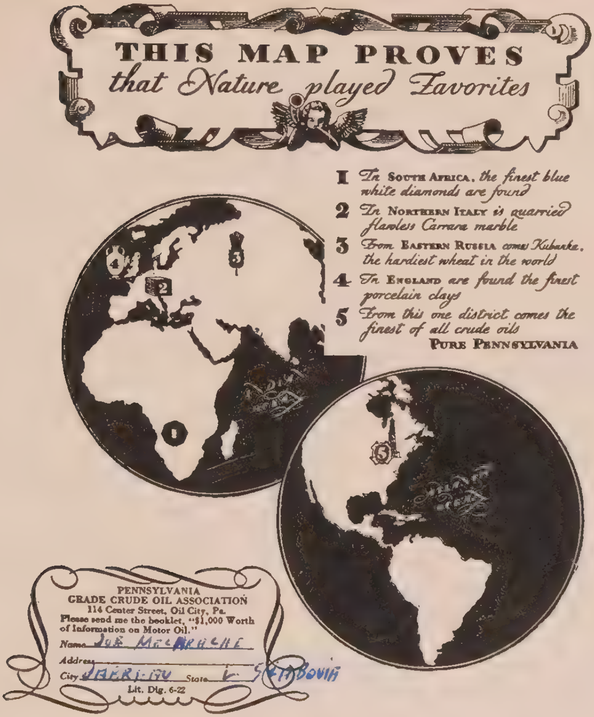
In the interpretation of relief model maps it should be kept in mind that the vertical scale is far out of proportion to the horizontal scale.

Air photography.—Air photography is the newest method for the showing of relief. Its most successful feature has been the true representation of the relative location or position of the land forms. It has also given us information about regions which man has found difficult to reach or inaccessible except by air, such as the polar areas, deep canyons, or lofty mountains. At present the results are only useful for the basis of a general survey, as the detailed features of the land are not shown in an air photographic map. But the system is still in its embryonic stage of development, and great improvement in its accomplishment is expected in the future. (See Figs. 92 and 95.)

Sketching.—The representation of relief on maps by sketching is one of the oldest and most useful methods. True, it gives us only a picture of the topography with a limited amount of detail and accuracy, but it is a method that can be rapidly and attractively executed if the technic is understood and mastered properly. If every student of geography should acquire at an early date the desire to sketch maps, it would greatly facilitate a better understanding of the relief features.

Map Representation—Cartograms.

Types of symbols.—In recent years there has been a marked growth of interest on the part of the business world in statistical analysis. Along with that has developed the prac-



1 *In* South Africa, *the finest blue white diamonds are found*

2 *In* Northern Italy *is quarried flawless Carrara marble*

3 *From* Eastern Russia *comes Kubanka, the hardiest wheat in the world*

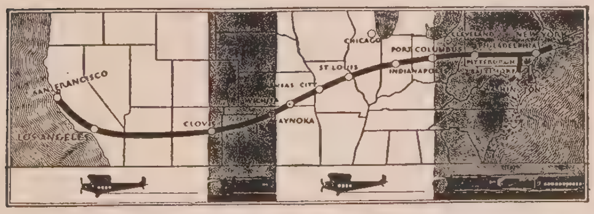
4 *In* England *are found the finest porcelain clays*

5 *From this one district comes the finest of all crude oils*
Pure Pennsylvania

PENNSYLVANIA
GRADE CRUDE OIL ASSOCIATION
114 Center Street, Oil City, Pa.
Please send me the booklet, "$1,000 Worth of Information on Motor Oil."
Name JOE MCCARRACHE
Address
City [illegible] State [illegible]
Lit. Dig. 6-22

Fig. 30.—An Example of the Map in Advertising.

Lindbergh pilots the first plane July 8th!—**Col. Charles A. Lindbergh is Consulting Aeronautical Engineer to the Pennsylvania Railroad and Chairman of the Technical Committee of the Transcontinental Air Transport, Inc. He has been active for many months in the work of investigation and preparation.**



By night a luxurious train—by day a safe, swift plane!—**Westbound, the Coast to Coast passenger travels on The Airway Limited of the Pennsylvania as far as Port Columbus—thence by a tri-motored plane of the Transcontinental Air Transport, Inc., to Waynoka, Okla.—that night by a Santa Fe train to Clovis, N. M.—then by plane to Los Angeles, arriving in the afternoon. (By plane the next morning to San Francisco) . . . Eastbound by the same route, leave Los Angeles 8:45 A.M., arrive New York 9:50 A.M. (second morning).**

Fig. 31.—Map Advertising Inauguration of Two-day Train-plane Service Coast to Coast, 1929.

tice of representing statistical data on maps. Psychologists tell us what has already been stated above, that the human mind comprehends pictures more easily than spoken or written words. Any system, therefore, which makes use of this natural characteristic has an inherent value. Such are graphs and cartograms. The latter are maps on which graphical material is plotted.

TYPES OF SYMBOLS IN CARTOGRAMS

A. Color, Shading, and Hatching.

B. Plane Surface Symbols.
  1. Bars. . . .
    - Plain Bars.
    - Composite Bars.
    - Hundred-per-cent Bars.
    - Pictorial Bars.
    - Area Bars.
  2. Circles. .
    - Plain Circles.
    - Hundred-per-cent Circles.
  3. Squares. .
    - Plain Squares.
    - Hundred-per-cent Squares.
  4. Triangles
    - Plain Triangles.
    - Hundred-per-cent Triangles.
  5. . . . . Equal-Area Dots.

C. Solid Symbols.
  1. Cubes.
  2. Cylinders.
  3. Spheres.
  4. Pyramids.

D. Curves.

E. Combination of two or more symbols.

The selection of symbols.—The choice of a symbol depends upon: (1) *Construction:* can the value of the symbol be easily computed, and can the symbol be easily drawn? (2) *Attention:* does the symbol attract and hold the attention? (3) *Interpretation*: is the symbol easily understood, and can it be accurately compared with other symbols of different values? (4) *Flexibility:* does restricted space limit the symbol's use? (5) *Popularity:* is the symbol much used? and (6) *Reproduction:* will the symbol lose its effectiveness through reduction or enlargement by photography or other methods of reproduction?

The relative merits of these six factors are determined by the purpose of the map. In the preparation of a map for publication it may not be possible to select the most effective symbol because its use may be prohibited by cost of reproduction or by the loss of its value through reduction in size. Then again, a map constructed for a business or sales project may stress attention beyond all other factors. But in every case, symbols should be selected and represented in such a manner as to avoid confusion, inaccuracy, and deception. This may necessitate a slight sacrifice in the purpose of the map, but all good things in this world involve some sacrifice.

Plane surface symbols.—*Equal-area dots* are among the most popular symbols. They are easily made with a Barch-Payzant lettering pen. Dots made with an ordinary pen are not equal-area dots, but rather spots which vary greatly in area and shape. If dots are intended to represent equal quantities, they should be equal themselves. Dots may be arranged symmetrically or plotted according to the geographical location of the quantity which they represent.

When the parts of the map or chart are of uniform size and the dots are evenly distributed within each part, the dot system is satisfactory; but if there is no relation between the size of the parts and the number of dots, the dot system fails, because a few dots in a small part of a map will be more impressive than a few dots in a large space.

In the use of dots to show distribution and value, a number of problems may arise. First, difficulty is encountered in placing the dots in their true representative positions; second, there may be required a greater number of dots than space can distinctly show; and third, in the reproduction of the map, a reduction in its size may destroy the visibility of the individual dots. Some of these difficulties may be overcome, first, by using other symbols in certain areas to prevent an excessive number of dots, and second, by changing the value of each dot so that it will not be necessary to use as many dots. However, if it is impossible to give an accurate representation of distribution, it is advisable either to use the systematic arrangement of dots or to label the cartogram as a representation of the general situation of the distribution of quantities expressed by the dots.

Vertical or horizontal bar.—Bar symbols are highly valued because they can be easily constructed and clearly interpreted. The linear distance is the measure of quantity. It stands out from the map as a major feature, and the eye is attracted and held by its significance. For most purposes, bars are superior to other plane-surface symbols.

Circles, squares, rectangles, and triangles as map symbols. An unwritten law in map making is clearness or self-explanation. Thus, the selection of a symbol should carry the idea of simplicity and interpretation. These qualities are not easily secured when circles, squares, rectangles and triangles are used. For example: Suppose we wish to show the population of two cities, one having 50,000 people, and the other 100,000 inhabitants. If the population is represented by bars, one bar must be twice as long as the other. This can be easily shown and interpreted. But suppose that we use square areas instead of bars. Since the ratio of population in the cities is 50,000 to 100,000, or 1 : 2, the sides of the squares must be in the ratio of one to the square root of two. Consequently, if the square areas are to be in the proportion of one to two, the sides of the squares must be in the proportion 1 to $\sqrt{2}$ or 1.4+. When squares are constructed according to 1 : 1.4, their areas will not appear materially different. It is practically impossible to tell by a glance at square areas that one city is twice as large as the other. The mistake is often made of making the sides of one square twice as long as those of the other. As a result, the area of one square will be four times as large as the other.

The same difficulty is encountered in the use of circles or other plane-area symbols. If one makes the radius of one circle twice as great as the radius of the other, the second circle will be four times as great as the first in area. The radius must be in the relation of one to the square root of two if the two areas are to be in the proportion of 1 : 2.

Nevertheless, there are conditions that warrant this tedious computation of square root. Circles, squares, and so forth are frequently used successfully with the equal-area dot system and in many other scientific maps where accuracy surpasses the importance of ease in construction and interpretation.

One advantage of squares, triangles, and rectangles over circles is that their shape may correspond to that area in which they are located. For example, the State of Pennsylvania is rectangular in shape, therefore a rectangular symbol would have a similar form. In a like manner, a square-area symbol would correspond to the shape of Ohio.

Cubes, pyramids, cylinders, and spheres.—What has been said about plane-area symbols in regard to construction and interpretation applies also to solids or three-dimension symbols the sizes of which are still harder to judge by the eye. An important rule in the construction of cartograms is not to use more dimensions than necessary.

One attractive phase of solids is that they permit the representation of greater quantities in a given area than plane-area symbols. Solids are successfully combined with other symbols in map representation. For example, the population of cities may be shown by spheres or some other three-dimension symbol, while the rural population is represented in terms of equal-area dots. The difficulty of computing the value of solids may be somewhat obviated by the use of a slide rule and a proportional scale. The most distinct disadvantage in the use of solids is the fact that they are difficult to compare and interpret.

Color, shading, and hatching.—For general purposes, the most satisfactory symbols are color, shading, or hatching. Color is impressive and easily interpreted, but it is expensive to reproduce, for which reason color is not extensively used. The greatest difficulty encountered in the use of color is selection. The use of bright colors to show insignificant facts may create a wrong impression. As far as possible, colors should be arranged according to the rainbow or spectrum.

Shading and hatching are more frequently used than solid colors, because a few different kinds of shadings, which have a definite order of intensity, ranging from solid white to solid black, can be easily devised. These shadings can be further modified, if so desired, by successive hatchings or crosshatching. Another advantage of shading and hatching is that they do not interfere with lettering which may be added to the various parts of the maps. If the maps are to be reduced in size in the process of reproduction, care should be taken in advance to have the hatching lines and grades of shading sufficiently distinct so that they will reproduce successfully and not blend to such an extent as to destroy visibility and interpretation.

Other features on the map should be clearly expressed without unnecessary exaggeration. The quality of the paper deserves recognition. A fine map cannot be constructed on cheap coarse-textured paper, for where such is used a smooth ink line cannot be drawn, and color smears.

In the use of the map emphasis should be placed on simplicity. It is a mistake to try putting all data on one map. Each map ought to have its own single purpose properly executed. Writing on maps is to be avoided. All expressions should be carefully designated by symbols and printing. The legend of the map should be self-explanatory.

Accuracy is a most important function in the development of a map. There seems to be a tendency to accept map representation unqualifiedly. Therefore it should be free from error and misrepresentation. Beauty is also essential. It aids the mental faculty in grasping the map's significance. Legibility should be constantly kept in mind as an essential map requisite. If the map is to be reproduced, the nature of the process should be known as well as whether the map is to be enlarged or reduced in size. A considerable amount of adjustment to reproduction is necessary, in order to get the maximum results.

Outline maps.—Base maps should be used continuously in the study of geography. They greatly facilitate the ease of understanding the subject and of fixing the essentials definitely in memory. The motive and thought in use of outline maps have been well stated by Ridgeley: "The use of outline maps is of highest value when the student has a motive for completing the outline map by entering upon it, through his own efforts, specific geographic or historic data. The outline map offers one of the best opportunities in school work for self-expression by the student. He learns 'by doing' in a definite and orderly manner. He is both map-maker and map-interpreter. The process of completing the outline map calls for clear thinking and accurate interpretation as the work on the map proceeds. The hand and the mind must work together in the development of any outline map, so that a good mental concept of the meaning of the map will have been obtained in the process of making the map. Only by developing thought processes along with the manual processes can the full educational value of outline maps be secured."

CHAPTER VI

MAJOR CLIMATIC REGIONS OF THE EARTH

Nature and Meaning of Climate.

Climate and weather.—The term " climate " comes from the Greek word, *Klima,* meaning a slope or inclination. It was originally used to denote the effect of the oblique rays of the sun on the temperatures of the earth and its atmosphere, and later came to mean about the same as our word " zone." Thus a change of latitude in the days of Aristotle meant a change of climate. It gradually came to be seen, however, that such a change meant not only a change in the angle at which the sun's rays strike the earth, involving a change in temperature and in the length of day and night, but also a change in other atmospheric conditions such as moisture, pressure and winds. So, to-day, climate has come to mean the summation or resultant of the average atmospheric conditions of a place or region for a long period of time. In other words, the " climate " of a place is its " average weather," the latter term meaning the physical condition of the atmosphere at a given time or during a limited period.

The difference between climate and weather, as Mark Twain's schoolboy stated it, is that, " climate lasts all the time, while the weather changes every day." More scientifically perhaps, but hardly more clearly, this difference is expressed in the definition of climate given by the great German authority, Dr. Julius Hann, in his " Handbook of Climatology " as follows: " By climate we mean the sum total of the meteorological phenomena that characterize the average condition of the atmosphere at any one place on the earth's surface. That which we call weather is only one phase in the succession of phenomena whose complete cycle, recurring with greater or less uniformity every year, constitutes the climate of any locality."

In another definition, Hann represents climate as "the sum total of the meteorological conditions in so far as they affect animal or vegetable life." This brings out the point of view considered important by geographers from the time of Humboldt to the present, namely, that the word "climate" is customarily applied to the consideration of the meteorological conditions in their relation to organic life, and especially to the life of man. Thus, Appleton's "Physical Geography" says: "By Climate is meant the state of the atmosphere in regard to the conditions that make it favorable to human welfare."

According to this point of view, then, it seems worth while, in undertaking to list or classify the climatic regions of the earth, to take into consideration some form of life related to human activity or welfare, such as vegetation, which bears a very important relation to activities like hunting, grazing, lumbering, and farming.

The Classification of Climate.

Climatic zones of vegetation.—The development of plant life requires the climatic factors of light, heat, and moisture as well as soil; and heat and moisture, for example, are found combined in various proportions in different parts of the globe. So it is with other factors. Consequently, these varied combinations of environmental factors give rise to widely different vegetation in different areas. However, a more or less definite classification of vegetation on the basis of climatic factors is possible. Thus Dr. Willis L. Moore, former chief of the United States Weather Bureau, following the example of Humboldt and using terms which express in a general way the vegetation characteristics of each climatic zone on the basis of temperatures, gives the following classification:

Zones	Average Temperature
1. Palms and bananas	78°–82° F.
2. Tree ferns and figs	73 –78
3. Myrtles and laurels	68 –73
4. Evergreens	60 –68
5. Deciduous trees	48 –60
6. Conifers	40 –48
7. Lichens, saxifragus, and dwarf shrubs	32 –40
8. Lichens and mosses	32 and under

It may be observed that these zones in a more or less general way extend around the world in irregular belts much as do the isotherms. However, there are many interruptions, such as, for example, the oceans extending north and south between the continents and the varying character of the rainfall in different places. Moreover, similar belts encircle many mountains at the different heights above sea level at which the corresponding temperatures may be found. Thus, within the tropics it is possible to encounter all the above zones from tropical palms to polar mosses in ascending a single mountain of sufficient elevation, provided one selects a mountain where there is plenty of rainfall. The latter, however, may depend on the direction of the prevailing winds, the distance from the ocean, and the presence or absence of high mountain ranges intervening between the peak selected and the ocean from which the prevailing winds blow.

Various classes of climate.—Thus it may be seen that there are various difficulties in the way of setting up any classification of climate based on so simple a scheme as a zonal distribution of plants according to temperature. In fact, classifying climate is like many other things. The classification may be done in different ways according to the basis selected. Thus, from one geographical point of view, climate may be continental, oceanic, or insular and littoral. Or, according to the topography of the land, we may have mountain climates, valley climates, desert climates, and so on. Again, on the basis of temperature and humidity, we may speak of hot climate, intermediate climate, of damp or moist climate, and of dry or arid climate. Finally, from a physiological standpoint, there are rigorous, relaxing, or invigorating climates, according to the general effects of the particular climate; or mild, pleasant, humid, or disagreeable climates, according to the general sensation produced upon the people in the region.

These terms indicate something of the human importance of climate, and emphasize the need, as well as the difficulty, of finding some scheme of classification in which similar climatic types in different parts of the world may be grouped with some consideration of their geographical distribution.

Factors to be considered in classifying climate.—Since climate has to do with the normal condition of the air with respect to light, heat, moisture, pressure, and wind direction, it naturally follows that any scientific scheme for classifying climate must take into consideration the factors which influence the foregoing elements. The chief environmental factors affecting these atmospheric conditions are: altitude, latitude, mountains, winds, ocean currents, and the distribution of land and water.

Thus, *altitude* affects temperature, which decreases with height above the sea; and, of course, *latitude* has a direct bearing upon light and heat. Other things equal, both decrease in intensity and amount as one goes from the equator towards the poles; in other words, both light and heat decrease with an increase of latitude.

Mountains, besides affecting temperature through their greater altitude, also influence climate in regard to moisture. They may obstruct the free movement of winds, thus preventing their bringing warmth and moisture to a region, or they may cut off cold winds, thus contributing to the mildness of a region's climate. Their influence upon rainfall is very pronounced. As an air current moves up a mountain, the cooling due to increased elevation brings about increased precipitation, up to, say, 6000 or 7000 feet in the temperate zones. Above this height the precipitation is likely to diminish, owing to the reduced amount of the air's vapor content.

This relation of rainfall to altitude is modified greatly, however, by the *prevailing winds.* Thus, mountains exposed to damp prevailing winds tend to have the windward side wet and the leeward side dry. Consequently, it makes considerable climatic difference to a region whether a mountain range lies between it and an ocean from which the prevailing winds come, and particularly whether this range runs perpendicular or parallel to the wind direction.

Ocean currents directly affect the temperature and moisture of the winds which blow over them. So the climate of a place is bound to be modified by winds that regularly reach it after blowing over an ocean current. The latter may be either warm or cold, and its influence on the prevailing wind, and so on the adjacent region, will vary accordingly. The influence of the ocean current on the nearby land will depend largely on whether the prevailing wind blows from the current towards the land or vice versa.

So the *distribution of land and water* is important. If the region is on or near the coast of a continent, the oceanic influence on its climate will, of course, be much greater than if the region is far from the coast and located away in the interior. And, naturally, it will make a difference whether the region is on the windward margin of the continent, that is, the side where the wind strikes first in coming from the ocean, or whether it is on the opposite or leeward side with respect to the prevailing winds.

Perhaps the most fundamental factor in distinguishing the climates of the world is the division of the earth's surface into land and water, into continents and oceans. So we have *continental climates,* which are characterized by a tendency to extremes in all the climatic elements, but particularly in temperature, and we have *oceanic* or *marine types* of climate in which temperature is more equable, moisture more constant, and rainfall frequent. This factor, then, is bound to be important in any system of classification of climates.

As coastal regions have characteristics intermediate between oceanic types of climate, such as those of islands in the middle of the Pacific, and continental types of climate, such as that of a plateau in the interior of Asia, a climatic classification scheme should recognize the differences between *continental interiors* and *coasts,* and also between windward and leeward coasts. Similarly, the importance of elevation requires some recognition of highlands and lowlands.

Finally, light, heat, pressure, and wind being essential climatic conditions, it seems necessary to take into consideration *the great zones* of temperature, light, and wind-direction which encircle the globe in east-and-west belts. While there are not strictly zones of climate, there are definite climatic regions within zones, and these regions recur with more or less regularity within the same zone in each of the continents and in both hemispheres. In this scheme, however, Europe and Asia being continuous, are considered one continent, Eurasia; while in the Southern Hemisphere, the greater proportion of water and the narrowing of the continents give more of an oceanic influence, and fewer continental interior climatic regions.

Climatic Factors.

I. **Light.**—Light is a vital factor for existence, as no one can live very long without it. The ultra-violet rays, whether coming from sunlight or produced artificially, are essential to life.

All of our food is responsible to light through the agency of the green plants by a process known as photosynthesis. This consists in the production of sugar called glucose out of carbon dioxide and water. The green granules in plant leaves called chloroplasts, the substance which gives a green color to plants, have the power to perform this process with the aid of light.

Visibility.—Light makes it possible for us to see where we are going and what we are doing. Without light and the faculty to use it our activities would be decidedly limited.

Nearly all of man's work is governed—in part, at least—by night and day, a condition in which light is the controlling factor. In a like manner, seasonal activities are influenced by the length of the periods of light and darkness. For example, in the polar areas the period of long days is the time of intensive activity, while during the long winter nights of nearly twenty-four hours of darkness man is confined to a stage of more or less dormancy.

The amount of sunlight received at a given place depends upon (1) the rotation of the earth and its relation to the sun, which brings about day and night; (2) the position of the earth's axis and the revolution of the earth around the sun, which creates seasons; and (3) the conditions of the atmosphere, as to the degree of cloudiness, fog, smoke, and the like.

Duration and intensity of light.—In the growth of plants, light influences carbon assimilation and, consequently, nutrition, so that the longer daily periods of sunlight in the higher latitudes, therefore, tend to compensate somewhat for the shorter growing seasons, thus permitting the growing of crops like barley and wheat nearer polar circles than would otherwise be possible. In high altitudes, both the intensity of light by day and of cold at night combine to handicap plant growth.

II. **Heat.**—*Source.*—The earth obtains nearly all of its heat from the sun in the form of radiant energy, which is emitted from the sun by the process of radiation. The atmosphere, however, is only slightly warmed by heat direct from the sun. A much greater effect is produced by the rays which are absorbed and radiated by the earth. Possibly less than ten per cent of the heat of the atmosphere is obtained directly from the sun. Thus the air receives the sun's heat, first, as it comes to the earth, and second, as it leaves the earth.

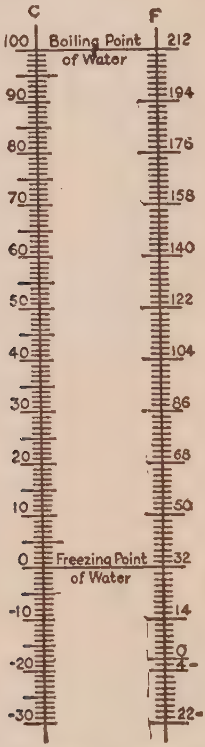


Fig. 32.—Comparison of Centigrade (C) and Fahrenheit (F) Thermometer Scales.

The latter is one reason why the air is warmer near sea level than at high altitudes in the same latitude. The upper air is everywhere cold, and in the space beyond the atmosphere the temperature is constantly below zero.

Expression of temperature.—Temperature is a general term used to express the intensity of degree of heat.[1] The average temperature may be given for days, months, seasons, or years. It is customary to obtain the average of a great number of years to get the *mean annual temperature,* or for many Julys to get the *mean monthly temperature* for that month. The difference between highest and lowest temperatures gives the *range of temperature.*

A farmer is more concerned with the highest and lowest temperature than with the average temperature. A freezing temperature may destroy his crops, but if the low temperature is known in advance he may take the necessary precaution to prevent destruction. In determining the type of agricultural practice, in general, records of range of temperature disclose more information than the average records. The range of temperature is important to human beings in numerous other ways. It may tell whether the nights and the days are cool or hot, hence expressing the expected degree of human comfort. Many famous health resorts, for example, depend for their popularity on warm days followed by crisp nights. A range in

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[1] The two common thermometers used in reading temperature are the Fahrenheit (F) and Centigrade (C). On the Fahrenheit the temperature of boiling water (under standard conditions, which means sea level and normal pressure) is marked 212°, and on the Centigrade scale, 100° (see Fig. 32).

The freezing point (temperature of melting ice) is marked 32°, on the Fahrenheit scale, and 0° (zero) on the Centigrade scale. Thus, between the freezing point and the boiling point on the Fahrenheit scale are 180°, and on the Centigrade scale 100°. That is, 180° on the Fahrenheit scale equals 100° on the Centigrade scale, or 1.8° on the Fahrenheit scale equals 1° on the Centigrade. Therefore, the change from one scale to another may be made by the following formula:

$$\text{Degree C.} \times 1.8 + 32 = \text{Degree F.}$$

$$\frac{\text{Degree F.} - 32}{1.8} = \text{Degree C.}$$

For scientific investigations and in countries where the metric system has been adopted the Centigrade scale is used in preference to the Fahrenheit scale.

temperature means variability, and a changing temperature is invigorating.

Causes for differences in temperature on the earth. (A) *Changing positions of the sun.*—The sun is higher in the heavens: (1) at midday than late in the day; (2) in summer than in winter; and (3) in tropical regions than in temperate and polar regions. When the sun is low in the heavens it warms less than when it is high; because, first, a given number of oblique rays spread over a greater area than the same number of vertical rays, or the amount of area covered is inversely proportional to the angle of the sun's rays above the horizontal; as a result, the amount of heat received per unit area is less in polar regions than in tropical, less in winter than in summer, and less in the afternoon than at midday; second, the rays pass through a greater thickness of the atmosphere when the sun is low than when it is high; and third, oblique rays are turned away (reflected) more easily than vertical rays; thus the amount of heat absorbed by the earth's surface is somewhat proportional to the inclination of the rays, other conditions being the same. (See Fig. 33.)

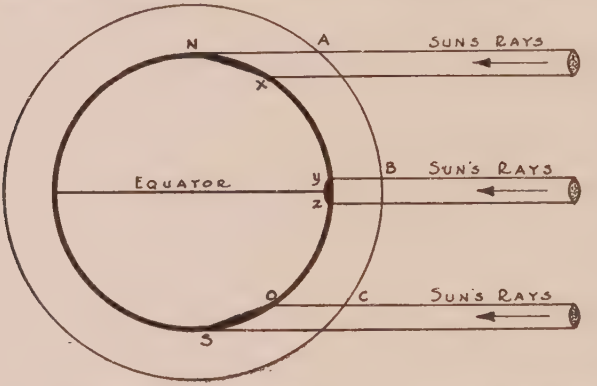

Fig. 33.—Diagram showing how a bundle of the sun's rays of a given diameter can have more heating effect on the earth's surface near the equator than near the poles. (1) It passes through a shorter distance of the atmosphere (*By* is less than *AN*).

(2) It strikes the earth's surface less obliquely (the angle at *y* is a right angle; those at *N* and *S* are acute).

(3) It has a smaller surface to heat (*yz* is much less than *Nx* or *SO*). Circle *ABC* may be considered the outer layer of the atmosphere.

(B) *Altitude and temperature.*—High altitudes are colder than low levels in the same latitude. This is true because (1) the air is thinner, and (2) the air contains less water vapor, carbon dioxide, and dust. For these reasons the air at high altitudes absorbs less heat directly from the sun, and less of that radiated from the lands. Approximately for every 300 feet of ascension the temperature drops 1° F. In addition to altitude, the size of the land mass, its summit area, its slope, its position in respect to the sun's rays, and the nature of the surface, such as the presence of snow, barren rock, and vegetation, all have a considerable degree of influence on temperature.

(C) *Temperature of land and water.*—Land is heated by radiant energy four or five times as fast as water. The reasons for the more rapid heating of the lands are: (1) Specific heat of land is less than that for water. Therefore, a given amount of heat raises the temperature of land more than that of water.

(2) Water reflects heat to a greater degree than land. The amount of heat reflected increases with increasing obliqueness of the sun's rays. It has been stated that at the equator 40 per cent of the insolation goes into heating the water; in latitude 60° less than five per cent is so used, and practically all the heat is reflected by water in high latitudes. The nature of the land's covering must also be considered. Snow or light-colored soils are greater reflecting substances than vegetation or dark soils.

(3) Land absorbs heat more readily than water does. It also radiates or loses its heat more rapidly than water.

(4) Convection movements or circulations of the water are established, thus preventing excessive heating at any one point. The land cannot distribute its heat by convection, except to a minor degree.

(5) Light and heat rays penetrate water, but not soil and rock to any great extent.

(6) Evaporation takes place to a greater extent from a water surface than from a land surface, other conditions being the same. Evaporation cools the surface from which it takes place. A wet soil receives the same amount of the sun's rays,

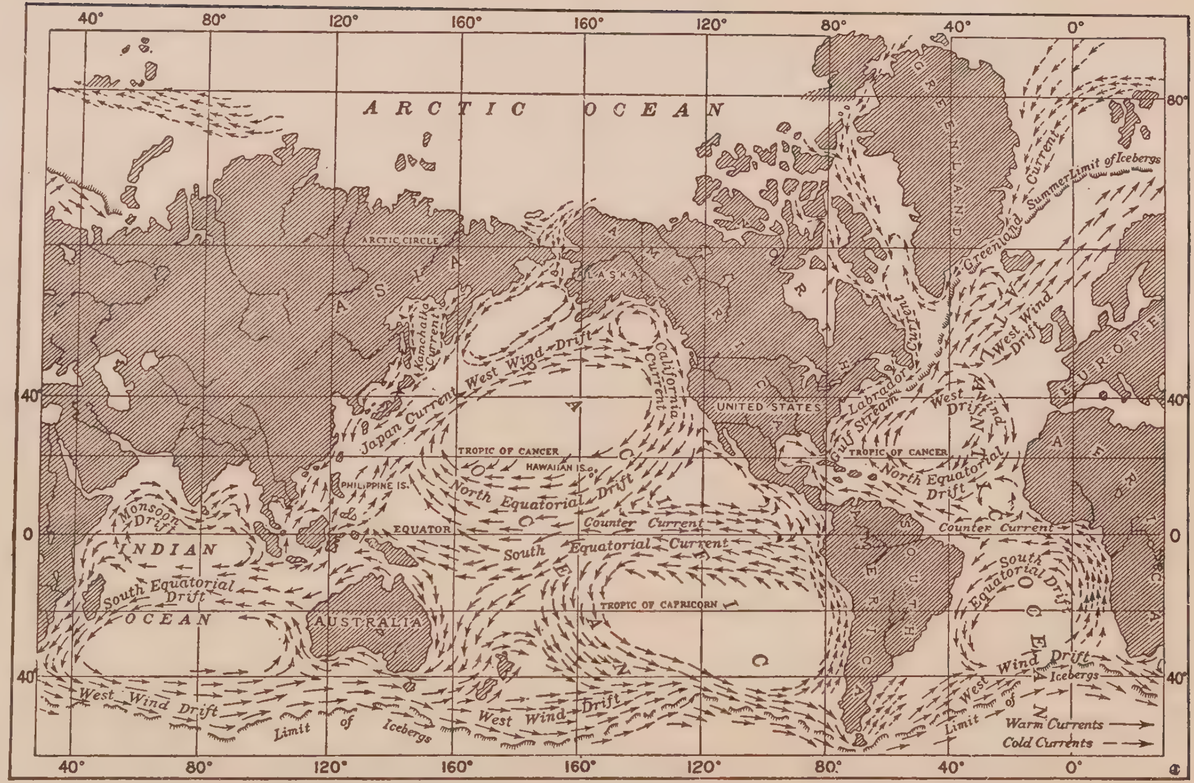

Fig. 34.—A Chart Showing the Principal Ocean Currents and Ocean Drifts of the World.

it absorbs more, and remains cooler than a dry soil. A sandy soil warms more rapidly than a clay soil owing largely to the greater percentage of moisture in clay soil than in soils of a sandy texture.

(D) *Ocean currents and temperature.*—The great currents of the oceans, by which the warm water of the equatorial regions is carried toward the poles and the cold water of the polar areas is transferred towards the equator, have a pronounced influence on the temperature of the air over the oceans and along the coast lands. The warm currents heat the air above them and increase its capacity to hold moisture; while the cold ocean currents cool the air above them and decrease its water-holding capacity. Thus winds blowing over these currents have their temperature influenced and, if these winds blow from water over lands, the temperature is communicated or transmitted to the land (see Fig. 34).

Representation of temperature on maps.—The importance of temperature and its changes from time to time and place to place make it necessary to have some means by which it may be recorded on maps or charts. Maps showing temperatures are called *thermal maps.* On such maps temperature is usually shown by lines, each of which connects points having the same temperature. Such lines are isotherms, and maps showing isotherms, are called *isothermal maps.* If the isotherm shows places having the same annual temperature, it is an annual isotherm. An isothermal map should always indicate the nature of the isotherm, telling whether it is annual, monthly, daily, seasonal, et cetera. Temperature may also be represented on maps by figures, color, and hatching. The isothermal map, however, is the type more generally used to show temperature.

On maps representing large areas isotherms are generally drawn according to temperature reduced to sea level. Otherwise, regions like the Andes, Alps, Pyrenees, and so forth, would appear like isolated areas of cold. It is known that temperature falls with height above sea level at the average rate of about 1° F. to every 300 feet. Thus, if the temperature of a place at an altitude of 6000 feet is 60°, it is put on the map or chart as 80° (60° + 20°). In other words, if the mountain were not there the temperature would be 80° rather than 60°. It should therefore be kept in mind that isothermal charts or maps are intended to show the temperature as it would be if the land were at sea level. In recent years, however, there has been a tendency to record actual temperatures rather than sea level equivalents.

World's mean annual temperature.—A survey of the mean annual isotherms (see Fig. 35) reveals the following characteristics:

(1) The isotherms run in a general eastward direction around the earth, showing the influence of latitude on temperature.

(2) The regions of greatest heat are not at the equator, but slightly north of it, on the extensive land masses of the northern hemisphere. Thus the influence of land on temperature is expressed.

A line along the axis of the belt of highest temperature is called the *heat equator*. This is not an isothermal line, as it connects places of highest temperature and not the same temperature. Since this map represents mean annual temperature, the heat equator is called *mean annual heat equator*.

(3) The isotherms are more regular in the Southern Hemisphere than in the Northern Hemisphere, indicating that the great water masses of the Southern Hemisphere have a tendency to make the air temperature uniform.

(4) In high latitudes the isotherms bend toward the poles over oceans and toward the equator over continents, while the opposite is true in low latitudes.

(5) At times the isotherms follow the coast lines, as can be observed along the coast of Africa and South America. The best illustrations of this are the isotherms 40° and 80° in the Northern Hemisphere and 70° in the Southern Hemisphere.

The isotherms always change their direction as they pass from land onto the oceans, turning toward the pole in high latitudes and toward the equator in low latitudes along the western margins of continents. These conditions are primarily due to the system of prevailing winds and ocean cur-

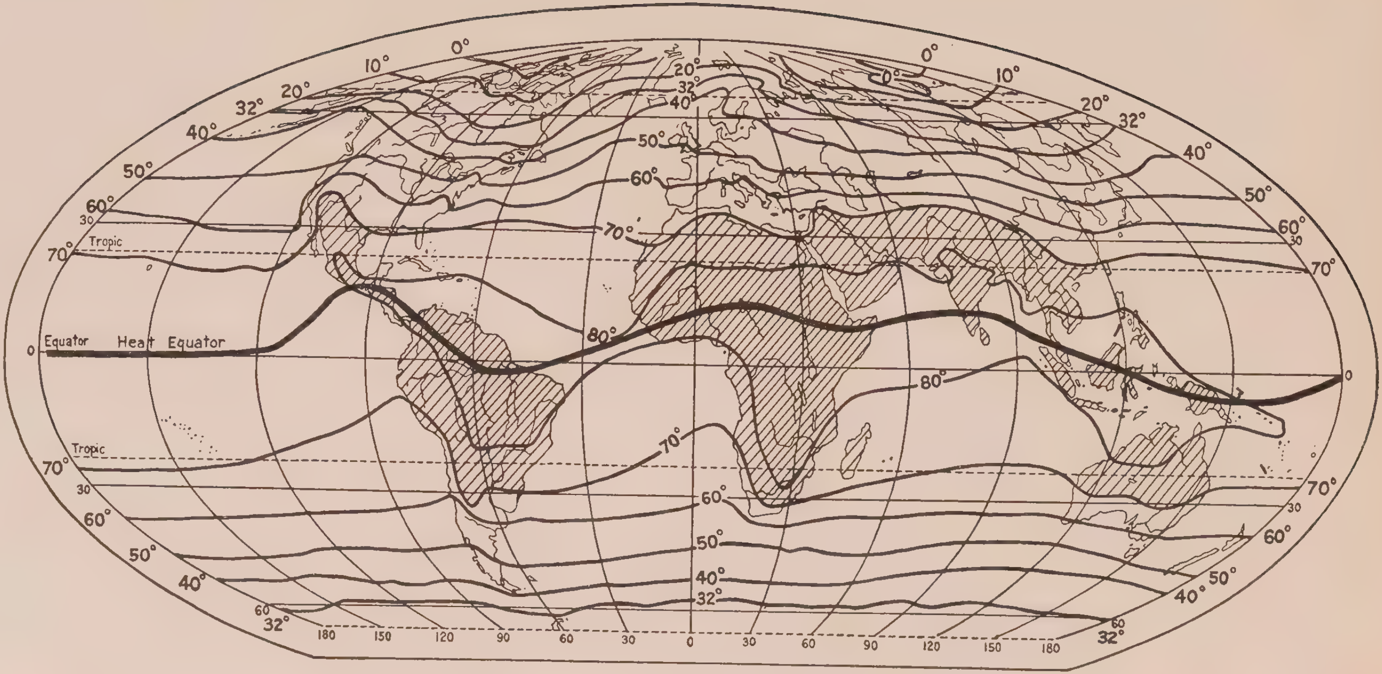

Fig. 35.—Mean Annual Isothermal Lines.

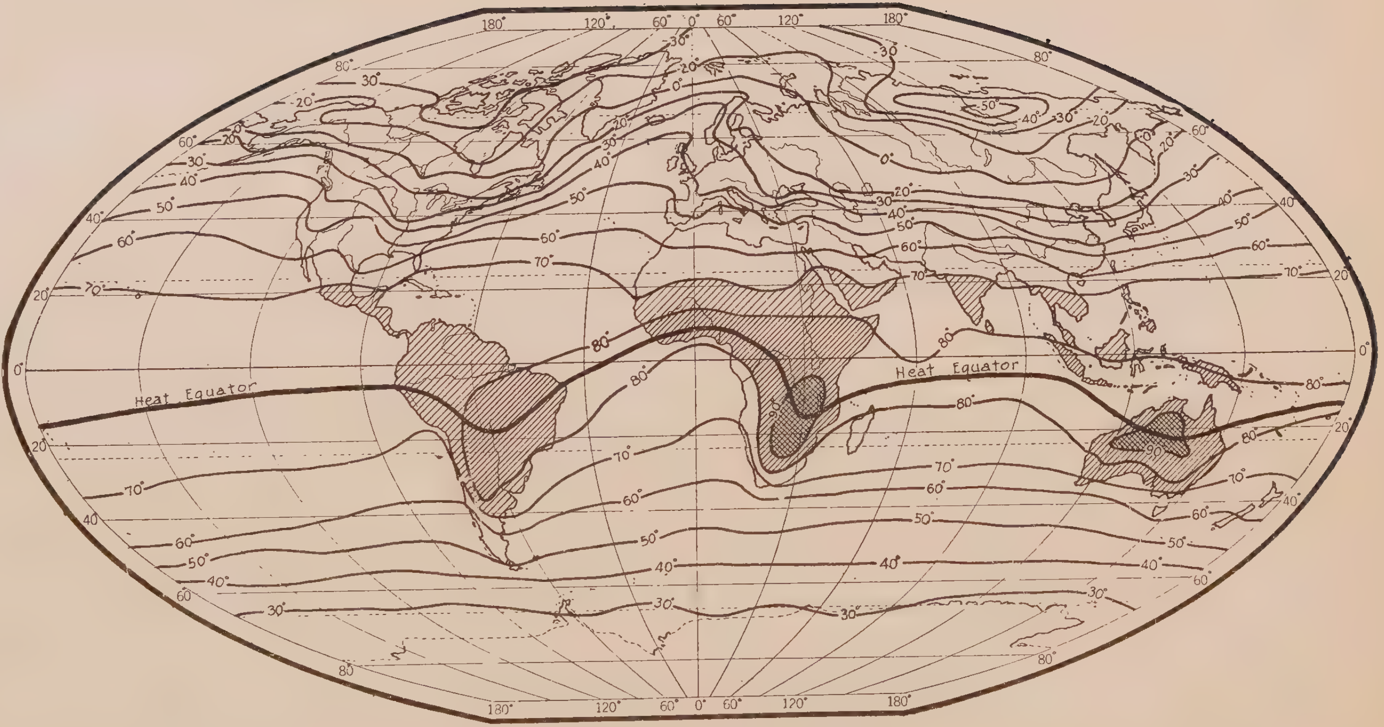

Fig. 36.—Isothermal Lines for January.

rents. The westerlies which are found in high latitudes carry the influence of the sea over the western coast of the continents, but not over their eastern coasts. Also ocean currents transfer warm equatorial waters toward the western coasts of continents in high latitudes, while cold currents flow along the same coasts in the low latitudes. The Gulf Stream and Peruvian currents are examples of this oceanic influence on temperature.

World's mean temperature in January and July.—The mean monthly temperature for January and July is shown in Figs. 36 and 37. January is the midsummer month of the Southern Hemisphere and July the midsummer month of the Northern Hemisphere.

(1) Isotherms for January show a greater distribution of low temperature over the Northern Hemisphere than for the month of July.

(2) The heat equator oscillates with seasons through 50° in latitude in some parts of the earth. The extent of migration is greater over land than over water.

(3) Temperature is lowest over land. Verkhoyansk, in Russia, is recognized as the cold pole. These extreme temperatures are due to the dryness of the air, calmness of the air, and vastness of land. These conditions, however, are not so effective as may seem. When the air is dry and calm, even though the temperature is far below freezing, man can exist without great discomfort.

It can be said that the principal factor in the distribution of temperature is the difference between continents and oceans. Lands are areas of contrasts, the hottest and coldest of the earth's surface. Asia is preëminent in this respect. In July nearly three-fourths of its surface has a temperature of over 68° F., while in January one-third has a temperature of below 50° F.

The temperature belts.—In the classification of the earth into temperature belts, it is understood that the temperature within the divisions is only relatively the same. The continuity of temperature within belts is interrupted by mountains, bodies of water, ocean currents, and numerous other features

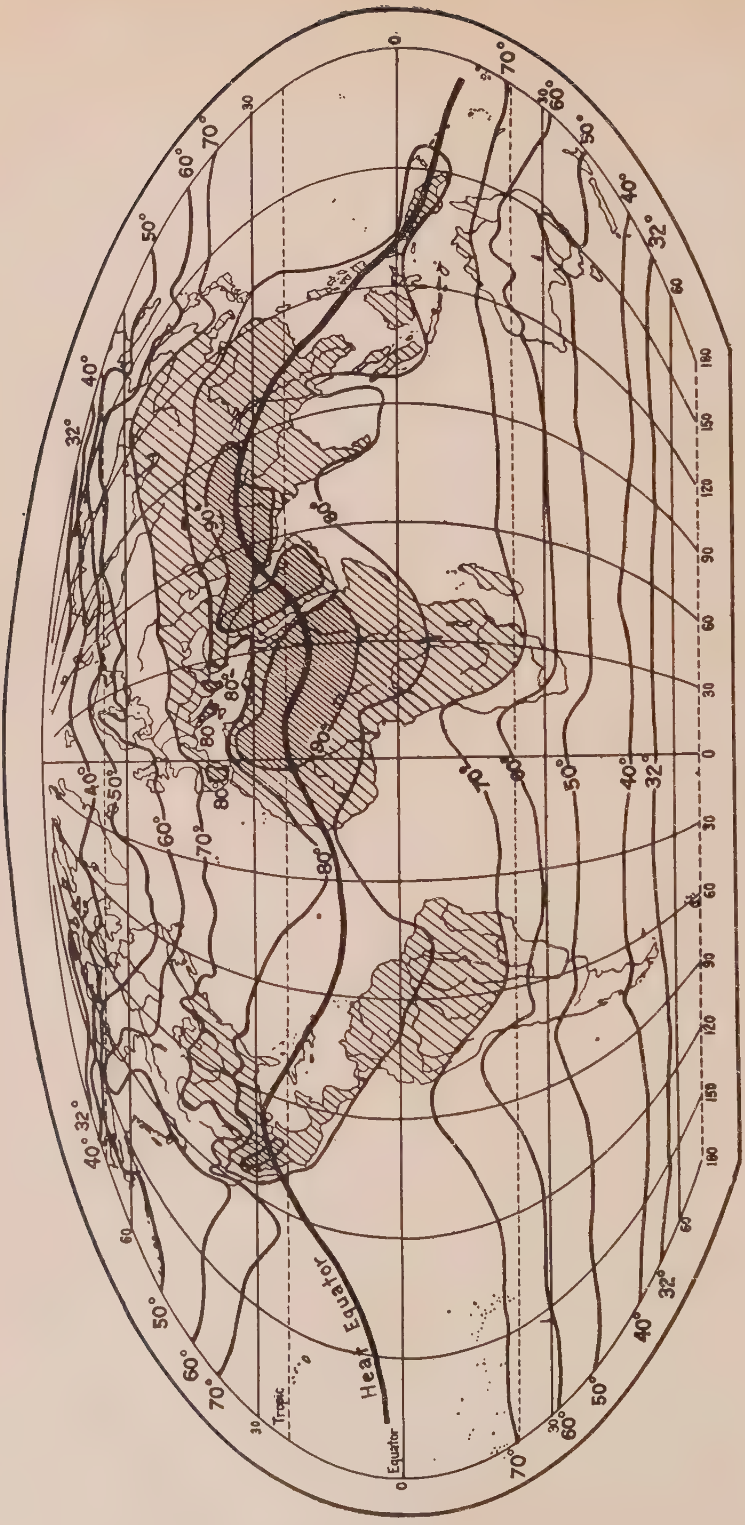

Fig. 37.—Isothermal Lines for July.

of the earth. Then again, temperature belts or zones should not be confused with insolation belts, or belts receiving the same amount of heat from the sun. The well-known torrid zone, temperate zones, and frigid zones, as bounded by the tropics and the polar circles, are not zones or belts of temperature, but zones of insolation and light. The reasons are that the temperature of the air is not determined alone by the heat absorbed directly from the sun; but it also depends upon the heat radiated from the earth's surface. Thus the temperature belts are irregular, and do not conform to such regular but arbitrary lines as the tropical and polar circles.

The major thermal characteristics of the earth's surface may be classified into three belts or zones, namely, the *tropical belt,* the *temperate belt,* and the *polar belt.* The boundaries of the tropical belt are defined by the 68° mean annual isotherms, or the polar limits of the palm tree, which is one of the truest expressions of tropical characteristics. Thus, between the limits of the 68° isotherms which are approximately 30° or 35° north and south of the equator is found the *tropical belt.* The *temperate belts* extend from the 68° mean annual isothermal line in each hemisphere to the corresponding isotherm of 50° for the warmest month in each hemisphere, or between approximately 35° and 70° north and south latitude. The 70° parallel north and south latitude is approximately along the 50° isotherm for the warmest month in each hemisphere. The *polar belts* extend to the pole from the poleward limits of the temperate belts.

In recent years there has been a tendency to refer to the tropical belt as the *low latitudes;* the temperate belts as the *intermediate latitudes;* and the polar belts as the *high latitudes.*

III. Atmospheric pressure.—*Atmospheric pressure* is an expression to denote the weight of the air. It has a marked effect on life directly and has much to do with winds and other elements of weather or climate. The effect of pressure is frequently felt in ascending or descending mountains. Bleeding from the nose, headaches, and temporary deafness may follow where sudden changes in pressure have been experienced.[1]

Differences in atmospheric pressure.—The pressure of the atmosphere may vary according to (1) altitude, (2) temperature, and (3) humidity. It varies from place to place at the same altitude, and from time to time at the same place. At elevation above sea level the pressure grows less. At an altitude of six miles, a little above the highest point of land, the pressure is less than one-fourth the normal pressure for sea level. On maps, the distribution of pressure may be shown by means of lines known as *isobars,* which connect places of equal pressure. Pressure readings are reduced to sea level, like the figures expressing temperature and for the same reason.

Pressure belts of the world.—The whole lower air mass may be divided into regions of low and high pressure. A hypothetical representation of the earth, consisting entirely of land or entirely of water, reveals a distribution of pressure as shown in Fig. 38. High pressure belts exist about 30° north and south of the equator, and at the poles, while intervening belts of low pressure occur at the margins of the polar circles and at the equator.

The excessive heat in the region of the equator is, primarily, the cause of the equatorial low pressure belt. The heated, moisture-laden air rises, and then flows poleward in the upper atmosphere, until, becoming cooled and heavier, it again descends to the earth, and so gives rise to the high pressure in the belts of the tropical circles. The low pressure belts at the margins of the polar circles occur where the air is rising, flowing from the temperate and polar regions. The extreme cold at the poles gives rise to the two polar high pressure belts.

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[1] The instrument by which pressure of the atmosphere is measured is called a barometer. The principles of the barometer are as follows: A tube more than 30 inches long, closed at one end, is filled with mercury. The open end is placed in a dish of mercury. The mercury in the inverted tube will sink according to the pressure on the mercury in the dish. When the mercury in the tube has reached an equilibrium, that is, when the weight of the column of mercury in the tube balances the pressure of the air on the mercury in the dish, a reading can be taken. If the experiment is performed at sea level, (standard conditions) a column of mercury about 30 inches high will balance the pressure of the air. Since the pressure of the air at sea level is about 15 pounds to the square inch, it follows that 30 inches or 760 millimeters of pressure is equivalent to about 15 pounds. A reading of less than 30 inches of atmospheric pressure, necessarily, means that the weight of the air is less than 15 pounds per square inch. If the pressure is more than 30 inches, it is said to be "high," and if less than 30 inches it is recognized as "low."

Since these belts are largely due to the amount of insolation, the position of the sun affects the location of the pressure belts at any given time. When the vertical sun is over the tropic of Cancer, the pressure belts are farther north, then migrating with the sun as it apparently moves south.

The shape, size, and surface characteristics of the continents have been referred to as affecting temperature. Thus, it is expected that the land masses also affect pressure. This is particularly true in respect to North America and Eurasia. These regions become very warm in summer, and low pressure centers are formed over them, while in the winter they become very cold and form high pressure areas. In the Southern Hemisphere, where the land masses are more uniform in temperature throughout the year, the pressure is also much more regular and without distinct seasonal variations.

IV. Wind.—The more or less horizontal air currents are known as *winds*. The vertical air movements at the equator and in the tropical high pressure belts are designated as *calms*.

General principles of winds.—The essential principles of winds are as follows:

(1) Wind is caused by a difference in atmospheric pressure, and blows from areas of high pressure to areas of low pressure.

(2) Wind is deflected to the right in the Northern Hemisphere and to the left in the Southern Hemisphere, owing to the rotation of the earth. The amount of deflection depends upon the speed of the wind and the latitude. This phenomenon has been found true for ocean currents as well as wind currents.

(3) The direction and velocity of the wind depend on the shape of the isobars and the interval between them. The difference in pressure or interval between isobars is known as the barometric gradient. It expresses the force which acts perpendicularly to the isobars.

(4) A wind is named after the direction from which it blows. Thus, a wind coming from the south is a south wind. The weather vane points into the wind. On weather maps and wind diagrams the direction of the wind is generally shown by arrows, flying with the wind.

Land and sea breezes.—A practical illustration of winds is found along lakes and seas. During the day, in summer, the land and the air above the land are warmer than the water and the air above the water; as a result, air moves from water towards land or from high pressure to low pressure. At night, the breeze often blows in the opposite direction. The reason for this is that the air above land cools faster than the air above water, because the lands radiate heat faster than water. These changes in temperature mean changes in pressure and also a reverse in direction of air movement. Frequently, at sunset, the temperature over the land and water is the same, which accounts for the evening calms. There is no air movement, because the pressure is the same over land and water.

Mountain valley breezes.—Similar winds are experienced in mountain valleys or gorges. The land cools and heavy air moves down the slopes, causing winds that may reach a high degree of velocity at night. During the day, as the land increases in temperature, the air moves up the valleys, but with less velocity than the evening or night valley breezes which blow down the slopes. Thus sea coasts and mountains both have refreshing breezes favorable to summer resorts.

Wind systems.—The arrangement of the pressure belts as shown in Fig. 38 gives rise to the planetary winds or regular wind systems. The air moves from the high pressure belts, located at the margins of the tropics, toward the equator, forming the *trade winds.* At about 10° or less on each side of the equator—positions change with the migration of the pressure belts—the trade winds, which have been gradually rising, become " calm " air currents moving nearly directly upwards. This vertical movement of air is called the *equatorial belt of calms,* or (formerly) the *doldrums.*

As the air in this belt of calms rises, it cools and flows toward the poles. This returning air, moving far above the earth's surface, forms the *anti-trade winds.* When the anti-trades reach the belts of high pressure at the margins of the tropics, they descend. This downward movement of the air creates the tropical belts of calms, sometimes called the *horse latitudes.*

From these high-pressure tropical calm belts the movement of the air is, in part, again toward the equator to form the trades, and in part, toward the poles to form the *prevailing westerlies.* In the polar regions, there is air movement from the high pressure areas, in the polar centers, toward the low pressure belts, near the margins of the polar regions. These planetary winds are deflected to the right in the Northern Hemisphere and to the left in the Southern Hemisphere.

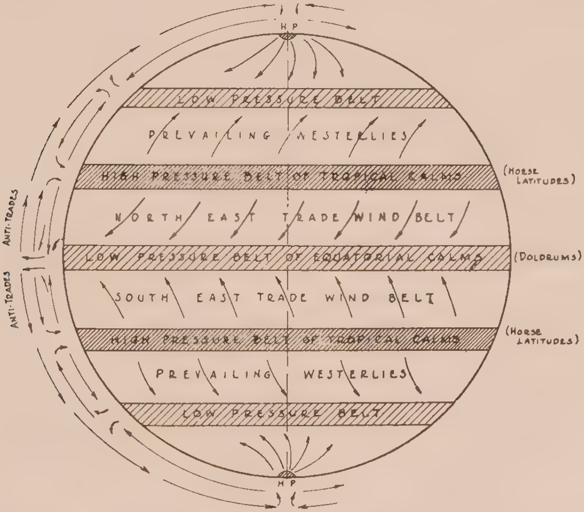

H P
LOW PRESSURE BELT
PREVAILING WESTERLIES
HIGH PRESSURE BELT OF TROPICAL CALMS
(HORSE LATITUDES)
ANTI-TRADES
NORTH EAST TRADE WIND BELT
LOW PRESSURE BELT OF EQUATORIAL CALMS
(DOLDRUMS)
ANTI-TRADES
SOUTH EAST TRADE WIND BELT
HIGH PRESSURE BELT OF TROPICAL CALMS
(HORSE LATITUDES)
PREVAILING WESTERLIES
LOW PRESSURE BELT
H P

Fig. 38.—Generalized Diagram of the Planetary Wind and Calm Belts.

V. **Moisture.**—The moisture of the earth passes through a regular cycle. Evaporated from the seas or moist lands, water is suspended in the air in the form of water vapor until it is condensed into fog or clouds, or falls as rain. Then it may flow on the surface of the land, or seep into the soil or rocks, often later to reappear in springs, and again be evaporated.

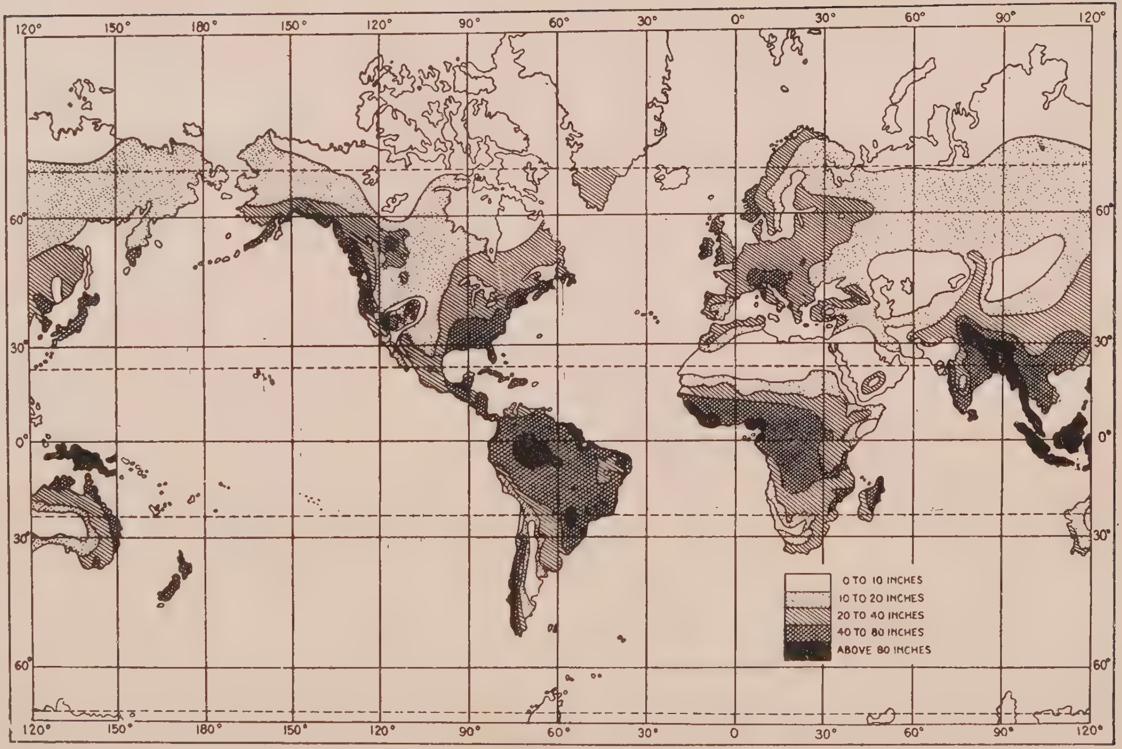


Fig. 39.—Mean Annual Rainfall.

Humidity.—The moisture or water vapor in the air may be expressed as *absolute humidity* and *relative humidity. Absolute humidity* represents the actual amount of vapor in the air, that is, the amount in pounds or quarts in a given volume of air. The pressure or weight of the water vapor cannot exceed a certain amount for a given temperature. When this limit is reached, the air is *saturated.* If the pressure of the water vapor increases beyond the saturation point, condensation takes place. *Relative humidity* represents the amount of vapor in the air, compared with the amount that it might hold at the same temperature. It is always measured in percentage. Thus the relative humidity of saturated air is 100 per cent; and 50 per cent if the air has only half as much water vapor as it can hold at that temperature.

Humidity is a geographical factor affecting people directly. The depressing, muggy, or sultry days are generally days of high humidity. A high humidity makes the air feel warmer in summer and colder in winter than the actual temperatures may indicate. In summer a humid air retards evaporation. Thus the evaporation from the human body is somewhat checked, which may cause discomfort and even disease, and may in part account for the characteristic tropical laziness. In winter, high humidity makes the air feel damp and chilly. The increased amount of water vapor in the air surrounding the human body accelerates the conduction of heat away from the body, creating a feeling of the so-called piercing, chilly atmosphere.

A high humidity is particularly favorable for certain agricultural plants, especially corn. The ideal weather condition for corn is a high temperature and high humidity. Since humidity checks evaporation, a region of high humidity does not need so much rain for successful crop production as one low in humidity.

Rainfall.—The presence of rain depends on two important conditions. First, there must be moisture in the air, and second, there must be some means by which this moist air is cooled to bring about condensation until the moisture falls as raindrops. The moist air may be cooled in two principal ways: (1) by ascending upwards into the colder upper regions of the atmosphere, and (2) by being blown as wind to colder regions.

Climatic Types and Regions.

Definitions.—Based upon the foregoing factors and principles, climate may be classified into a number of so-called *types,* depending upon the various combinations of climatic factors found in different places.

These types are grouped, first, within the great thermal zones or belts known as the *tropical* belt, the *temperate* zones, and the *polar* regions, each one of these major regions having two or more types. Next, since the polar regions and temperate zones are in both the Northern and the Southern Hemispheres, most of the types found in the Northern Hemisphere are found also south of the equator. Likewise, the same types of climate are found in both the Eastern and the Western Hemispheres.

A place or district having any given type of climate is called a *climatic region.* There are thus many more climatic regions than climatic types, for the same type may be found in from two to five different regions.

A classification of climatic types, and the climatic regions where they are found, are shown in the following map. Since many of these regions are large, extending over many degrees of latitude or longitude, it follows that some of them could be divided into smaller provinces or districts.

Types of Climate.

Polar Regions.

1. Polar Highlands or Ice-Cap type.
2. Polar Lowlands or Tundra type.

Temperate Zones.

3. Cold Temperate or Coniferous-Forest type.
4. Temperate Mountain and Plateau type.
5. Cool Temperate Oceanic or Marine type.
6. Temperate Grasslands or Prairie type.
7. Temperate Humid Interior type.

8. Cool Temperate East-Coast type.
9. Subtropical or Mediterranean type.
10. Temperate Arid Interior or Desert type.
11. Warm Temperate Oceanic or Monsoon type.

Tropical Belt.

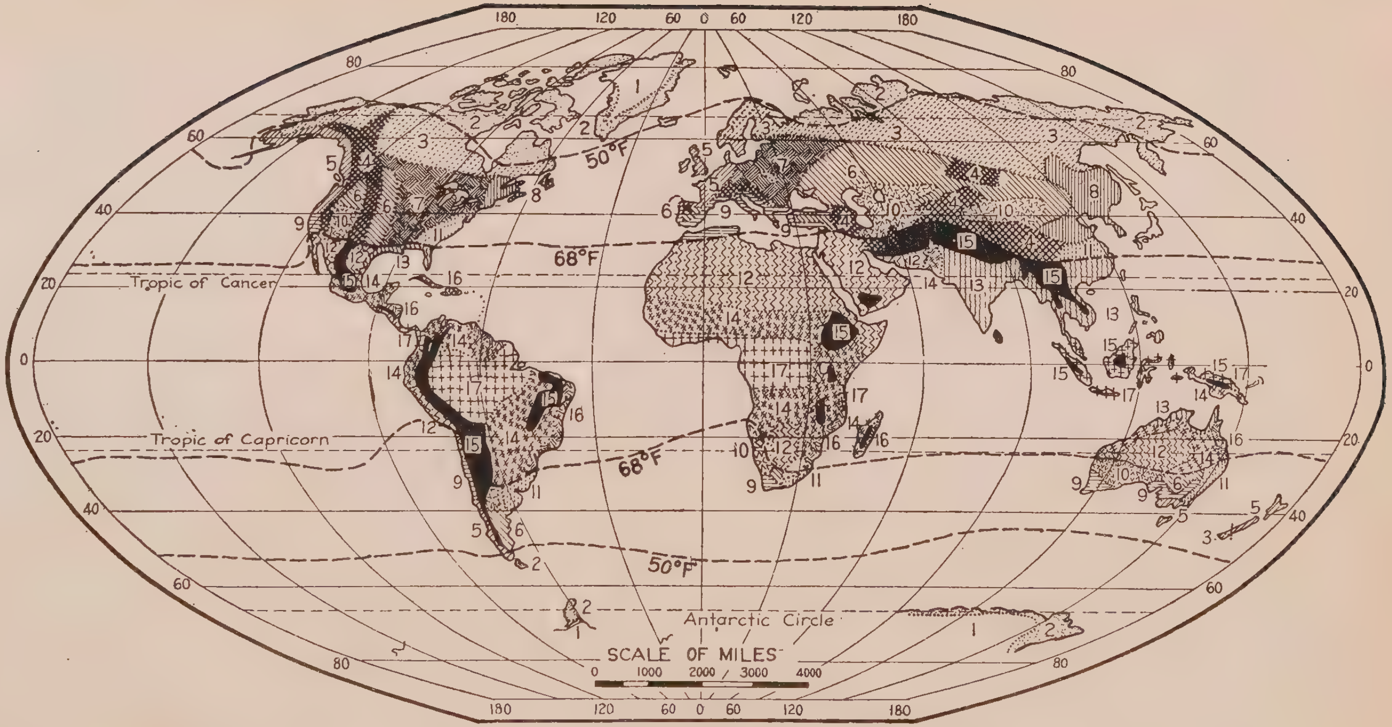
12. Dry Trade-Wind Deserts.
13. Tropical Monsoons.
14. Tropical Grasslands or Savannah type.
15. Tropical Mountain and Plateau type.
16. Moist Trade-Wind Coasts.
17. Equatorial type.

Climates of the Polar Regions.

Polar highlands.—These regions, covered for the most part with perpetual snow and ice, constitute the least-explored part of the earth's surface and offer to man hazards which, even in this day of the airship and the radio, he finds the greatest difficulty in overcoming. The extreme cold is due not only to the position of the regions around the poles in the highest latitude, but also to the elevation.

The two regions of this type, the arctic and the antarctic, differ in one important respect. In the former, the Arctic Ocean occupies a central position in the polar zone with the land chiefly around the margin, while at the south pole the high and extensive antarctic continent occupies the central place with the ocean around the rim. This makes the antarctic climate more frigid than that of the arctic. Practically all of the antarctic land is high and, consequently, of the ice-cap type of climate. In the north polar zone, however, the chief highland area is that of Greenland.

An exaggerated idea of the size of Greenland is usually obtained, owing to the general use of maps on the Mercator projection. As a matter of fact, the area of the whole arctic region is only eight per cent of that of the Northern Hemisphere; and of the arctic area, only about forty per cent is land. Stefansson brings out the important point that the lack of life in the polar highlands is not due to the high latitude, but to the high altitude.



Regions in part after Herbertson, Stamp, Jones and Whittlesey, and others

Polar Regions
1. Polar Highlands or Ice cap
2. Polar Lowlands or Tundra

Temperate Zones
3. Cold Temperate or Coniferous Forest
4. Temperate Mountain or Plateau
5. Temperate Oceanic or Marine
6. Temperate Grasslands or Prairie
7. Temperate Humid Interior
8. Cool Temperate East Coast
9. Sub-Tropical or Mediterranean
10. Temperate Arid Interior or Desert
11. Warm Temperate Oceanic or Monsoon

Tropical Belt
12. Dry Trade Wind Deserts
13. Tropical Monsoons
14. Tropical Grasslands or Savannah
15. Tropical Mountain or Plateau
16. Moist Trade Wind Coasts
17. Equatorial

Fig. 40.—Major Climatic Types and Regions.

The polar lowlands.—As pointed out above, this climatic type is only slightly represented in the Southern Hemisphere, as, for instance, the extreme tip of South America and a small area on the edge of the antarctic continent just below South America.

In the Northern Hemisphere, however, the greater poleward extension of the continents gives large areas of the tundra type in Alaska, Canada, Russia, and Siberia. Since the southern boundary of this region is the isotherm of 50° for the warmest month, it follows that such vegetation as exists must make rapid growth in the short cool summer. Above this isotherm forest trees and cereals do not grow, except some stunted bushes and trees near the margin, but the relatively high temperatures of the arctic summer, when the insolation is great, permit the growth of many kinds of plants, mostly mosses, lichens, and low types of plants, but some of them of a herbaceous character.

As the temperatures of air and soil practically exclude crops, agriculture is out of the question, but some development of grazing is possible, and, as the growing population of the world makes the meat shortage felt, it is likely that herds of reindeer, caribou, and so forth, may make these regions important contributors to the food supply.[1] Coal is mined in Spitzbergen; and other mineral deposits will attract men into the far north temporarily for profit, but few people will care to go there for permanent residence.

Temperate Zone Climates.

The cold temperate regions.—These are the coldest parts of the temperate zones. In the Southern Hemisphere, owing to the fact that the continents do not extend so far south, only the tip of South America and the mountains of South Island, New Zealand, are cold enough to belong to this climatic type.

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[1] Stefansson gives the following estimates of arctic grazing value for reindeer alone:

Alaska will support 2,000,000 reindeer on 200,000 square miles
Canada will support 10,000,000 reindeer on 1,000,000 square miles
Eurasia will support 20,000,000 reindeer on 2,000,000 square miles

—Problems of Polar Research, p. 229 (Amer. Geog. Soc. Serial Publication No. 7, 1928).

In the Northern Hemisphere the area includes a broad belt or zone lying right next to the polar regions and extending east and west entirely across Europe, Asia, and North America. The only breaks in this belt across the continents are the mountains of Scandinavia and Alaska. This is a zone of short, warm summers and of long, cold winters. The rainfall seldom exceeds 20 inches for the year, except where the belt comes within reach of oceanic winds of the west or windward coasts, as in Norway and in Alaska. However, much of the precipitation is in the form of snow which melts slowly, and, since the evaporation is relatively slight, the soil and vegetation get most of the moisture, which is plenty for the growth of trees.

The region is characterized everywhere by great forests of the evergreen coniferous type. The Siberian forests of this region are still somewhat inaccessible, partly because of the great distance from important markets and partly because their natural transportation outlets, the rivers, flow to the Arctic Ocean and are frozen much of the year, and in the spring their southern headwaters thaw out first, causing great ice-jams and floods in their lower courses. In Europe and Canada, however, logging, lumbering, and the pulpwood industries are already making inroads into these great coniferous forests, the world's greatest source of soft wood such as pine and fir.

The marine type of climate.—On the windward coasts of the continents of the temperate zone, which are the west coasts, since the winds here are the prevailing westerlies, we find in latitudes above 40° what is called the *cool temperate oceanic,* or *marine* type of climate. By some this is said to be the only really temperate climate in the so-called temperate zone. The fluctuations of temperature are less than in other regions of the same latitude. Thus Sitka, Alaska, lat. 57° 3′ north, has an annual temperature range of only 24.3°, while Nain, on the Labrador east coast of North America in about the same latitude, has an annual temperature range of 41.1°. The westerly winds from the ocean bring abundant rainfall. Thus the coasts of Washington and Oregon in this region have the heaviest recorded rainfall of any region in the United

States; that at Glenora, Oregon, for example, averaging for several years 136 inches.

This type of climate is found in North America along the west coast from San Francisco to Alaska, but is limited eastward by the Sierra Nevada and Cascade Mountains. In South America it characterizes the coast of Chile south of 40° south latitude. Africa does not extend far enough south to have this type, but New Zealand and, south of Australia, Tasmania, come within its influence. In northwestern Europe, however, the marine type of climate extends from the northwest corner of Spain to southern Norway, and extends far inland; for there is no north-south mountain range to act as a barrier to the warm moist winds from the Gulf Stream and the North At-

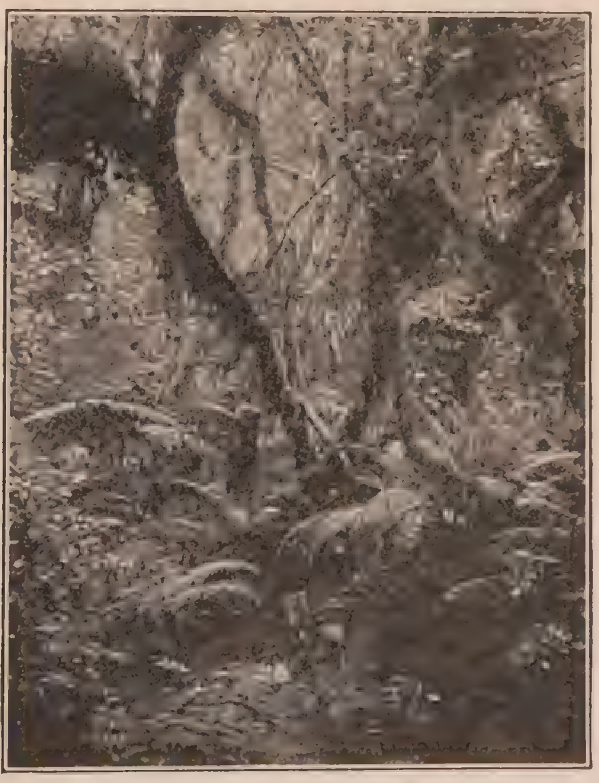


Fig. 41.—Native "Bush" (forest) in New Zealand. Note the great tree ferns and other differences between the vegetation here and the forests of the north temperate zone.

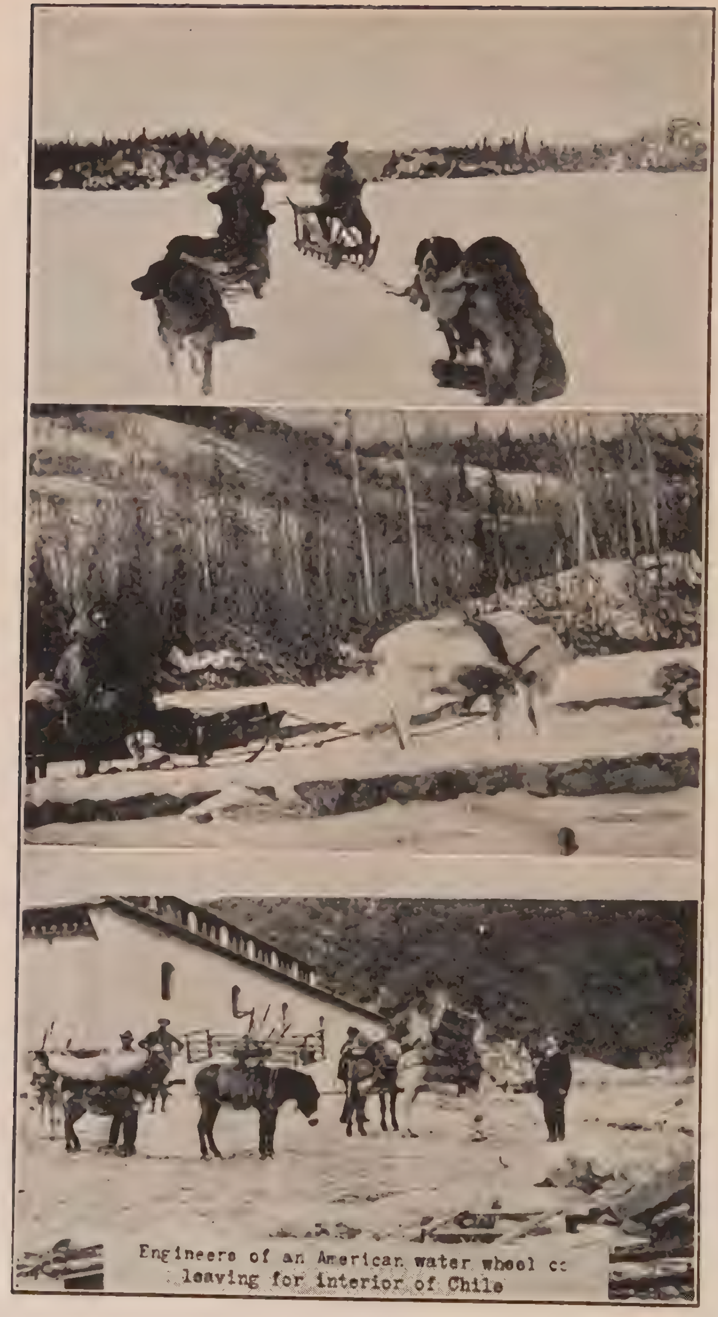

Engineers of an American water wheel c
leaving for interior of Chile

Fig. 42.
Upper.—Sledge with dogs (Southeastern Alaska).
Middle.—Sledge with reindeer (Southeastern Alaska).
Lower.—Donkeys with waterwheels.

lantic Drift. Consequently, the ocean influence spreads eastward from France and the British Isles across the great low plain of north central Europe, even to Russia. The change from the marine climate of northwestern Europe to the continental type of eastern Europe is very gradual; the plains of northern Germany may be said to be a transitional region.

Not all kinds of crops can be grown in a climate of such abundant rainfall, high humidity, and cloudiness; but oats, rye, and barley flourish, while the climate favors the growth of grass for pasture and of forests for timber. Thus England and New Zealand have both been famous for their sheep raising, and Washington and Oregon rank at the top of our lumber producing states. The Cascade Mountains get their name from the abundant waterfalls, and this section has the greatest potential water power of any region of the United States.

The temperate grasslands.—Since the temperate zones lie within the realm of the prevailing westerly winds we may expect to find in the interiors of the continents east of mountain and plateau barriers, regions where the rainfall is insufficient to grow forests, but adequate for grass. Such areas, far from oceanic influences, naturally have the extremes of temperature characteristic of continental interiors, but are known the world over as important grazing lands. One of the best examples of this type of climatic region is the great plain or prairie region of North America, extending from Canada to Texas just east of the Rocky Mountains, and the name "prairie type of climate" is frequently applied to this type. Other examples of the type are the great steppe regions of southeastern Russia in Europe and of southwestern Siberia and Mongolia in Asia. So also, but with a less extreme climate, owing to the narrower continents in the Southern Hemisphere, examples of this climatic region may be found in the pampas of Argentina, the veldt of South Africa and the Murray-Darling Basin in Australia.

The typical rainfall of these regions ranges from 10 to 30 inches, which is adequate for good pasture grass, but insufficient for forests, so the rolling plains are characterized by the lack of trees; and the contrasts of the green grass in spring, the dried-up appearance in late summer, and the covering of snow in winter are most striking in all these places, except that in Australia and South Africa snow seldom falls in these regions.

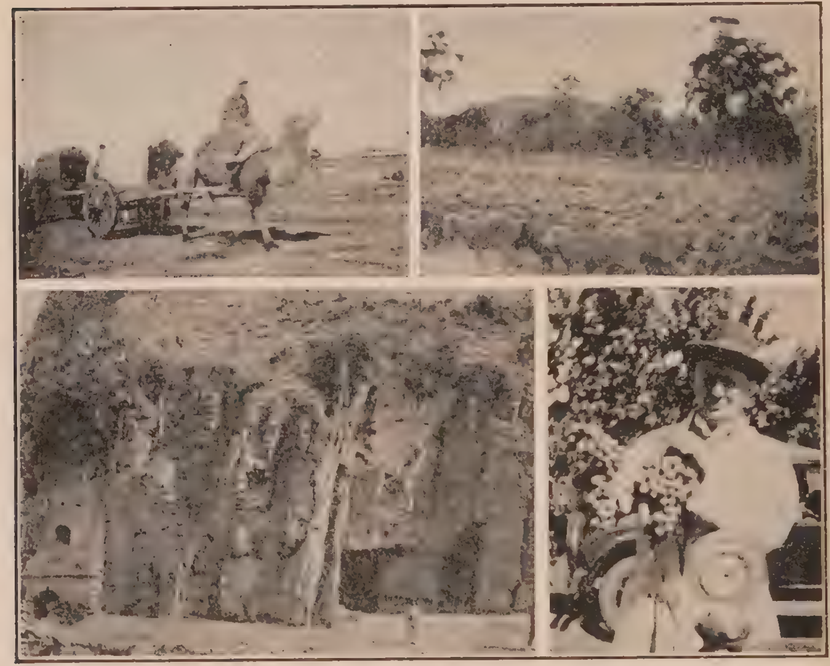


Fig. 43.—In Temperate Regions of Little Rainfall.

Upper right.—Sheep on road in New South Wales, Australia. These roadways are often a quarter mile or more wide, so the sheep transporting themselves from the "stations" (ranches) to market may graze on the way.

Lower right.—In an irrigated orchard, Victoria, Australia. The linen "duster" worn by the orchard owner when driving suggests the dusty roads. (Photos by C. C. H.)

Upper left.—A camel cart in Mongolia.

Lower left.—A dwelling in Mongolia. The inhabitants of interior China often dwell in cave houses excavated out of the loess banks. (Photos by Publicity Dept., U. S. Dept. of Commerce.)

In these grasslands early man, like the Indians of our western plains, was naturally a hunter. Then with social evolution came the domestication of animals, such as sheep, cattle, and horses, and the pastoral industry developed. In this stage wandering nomads seeking new pastures for their herds are the characteristic grassland dwellers. Droughts, causing a shortage of pasture, often give rise to tribal movements and sometimes to great population migrations. The social history of Europe, for example, records case after case of invasion of waves of migrating people from the grasslands of Central Asia.

In these regions of the Southern Hemisphere, sheep and cattle raising is still the leading industry, while in the great plains of the United States, also, grazing is the most important business. In Canada and in parts of this area in our own country where there is more rainfall, and in eastern Argentina, agriculture is becoming more important. Cultivation is also extending in the grasslands of Australia. Wheat, rye, oats, and barley are the main crops. The great "Inland Empire" east of the Cascade Mountains in Oregon and Washington is also one of our great wheat sections. In Mongolia and Manchuria these areas constitute one of the world's great undeveloped but potential food producing regions.

The temperate humid interiors.—The grassland interiors gradually merge into forest regions where the rainfall is sufficient. This is the case east of the 100° meridian in the United States and Canada and, in Europe, from Germany and Austria eastward through Russia into western Siberia in Asia. Throughout these regions great deciduous forests are the characteristic vegetation, the annual rainfall ranging from 30 inches upwards. Except in the drier margins of these areas, where trees are usually found chiefly along the streams, the great forests had to be cleared off the land before agriculture developed, thus giving rise to great lumber industries; but to-day both in Europe and the United States these sections constitute agricultural regions of the highest rank. Corn, wheat, cattle, hogs, and so on, are the leading products. The great Corn Belt of the United States must be considered in all the industrial, political, educational, and other important movements of the nation. The greater portion of the tobacco belt and the winter wheat belt of the United States can also be found in this region, as well as that of the spring wheat belt of this country and Canada.

The climate of these humid continental interiors is greatly influenced by the cyclonic and anticyclonic winds that pass in succession over the region bringing rainfall and temperature changes that make the climate one of the very best for man's development. The "highs" of the anticyclonic winds with their cold waves have a sort of whirling downward and outward motion that brings from the upper, cooler layers of the atmosphere ozone and high electric potential, for example, that seem to be stimulating and beneficial to man and to other animals. These cold winds generally come from the northwest, and this heavier air, together with the force with which the winds come, also scatters and diffuses the air next the surface which may have become more or less impure. All in all, these cyclonic wind systems help greatly in placing the temperate humid interiors among the environments most favorable for human progress.

Cool temperate east coasts.—On the eastward margins of the continents in the temperate zones chiefly above the latitude of 40°, are found the cool leeward coasts. In the Southern Hemisphere these areas are very limited, owing to the narrowness of the continents and the fact that only South America extends much beyond 40°. So we find this type of climate practically limited to the continents of North America and Asia. In the United States, New England is in this area, while the St. Lawrence valley and the maritime provinces of Canada, together with southern Newfoundland, have this type of climate. In Asia, portions of Manchuria, northern China, and Japan are represented.

This type of climate strongly resembles that of the humid continental interiors, but the extremes of heat, cold, and drought are modified by the oceanic influence due to nearness to the sea. But the climate is quite different from that of west coasts in the same latitude because the prevailing winds, being from the west, bring the continental influences to the east coasts, whereas in the marine type of the corresponding west coasts these same west winds bring the oceanic influences to the coast regions. Thus there is a great contrast between the cold, bleak climate of Newfoundland and the mild marine type of Ireland just across the Atlantic. Asia, being larger, has a more pronounced continental effect on this east-coast type than has North America. Thus Vladivostok averages about 18° colder in January than Portsmouth, New Hampshire. This more moderate winter temperature of New England is fortunate for the United States, as none of our ports are bothered much by ice. Even the St. Lawrence River is closed by ice only about five months in the year, whereas the Amur River in eastern Asia, though farther south, is ice-blocked for seven months.

These regions are also forest areas like the humid interiors of the temperate zone, but there is found here a larger proportion of conifers than in the interiors which have large areas of hardwood deciduous forests.

The life conditions, however, of the cool east coasts and of the continental humid interiors are quite similar; and also a great similarity is at once seen between the industrial and social life of New England, for example, and that of England and France, in the marine climatic region of Europe. The great concentration of population and manufacturing in the cool temperate east-coast region of the United States and of the cool temperate west-coast area of Europe has already made necessary the bringing-in of food supplies and raw materials from other regions. In this respect they are no longer self-supporting. Japan, likewise, in the cool temperate east-coast climate of Asia is already in the same situation as England, New England, and Germany.

The subtropical or Mediterranean regions.—The subtropical or Mediterranean regions are the warm temperate west or windward coasts below the latitude of 40°. This type of climate is most extensive and has been longest studied in the regions bordering the Mediterranean Sea, hence the name Mediterranean type. Other areas having this climatic type are southern California in the United States, central Chile in South America, Cape Colony in South Africa, southwestern Australia, and the west coast of southeastern Australia.

All these regions being near the tropical limits of the temperate zones are also known as subtropical regions, and being on west coasts are in winter under the rain-bringing influence of the westerly winds. In the summer, however, the movement of the sun polewards to the tropics, and the corresponding swing polewards of the planetary wind and calm belts, bring to these subtropical regions the influence of the dry trade winds and the dry tropical belts of calms. So this type of climate while always mild in temperature is characterized by dry summers and winter rains. The rainfall is usually slight, so irrigation is generally practiced in these areas. Most of the crops are grown during the winter season and harvested in the spring about the time the dry season begins. Fruit is an important product in all these regions, such fruits as oranges, lemons, figs, olives, and grapes, being characteristic.

The long dry season and the usually scanty rainfall compel the natural vegetation to utilize to the best advantages the moisture obtained in winter, and to protect itself against loss of moisture in summer, so trees like the olive with deep-growing roots, and small evergreen trees and shrubs with leaf systems which limit transpiration, or evaporation of moisture, are characteristic forms of vegetation here. Ordinary herbs and grass which need showers during the summer do not fare well in Mediterranean regions, so in summer the landscape, except where artificial watering is resorted to, tends toward a dusty, dried-out appearance.

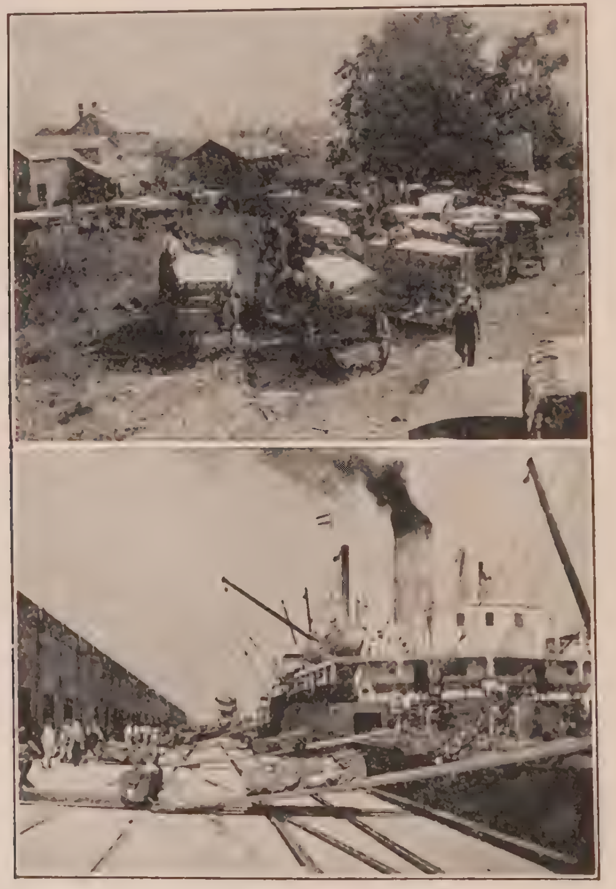
The typically mild, sunny climates of these regions are considered by many the best in the world. They, therefore, are much resorted to for recreation and pleasure. Resorts so noted as those of the Riviera in southern France and Italy are becoming rivaled on a smaller scale by those of southern California, for example. People from Pasadena, Riverside, Los Angeles, and San Diego, California, tell us that no better climate can be found anywhere. The moving-picture producing industry centered at Hollywood, California, utilizes to advantage this mild sunny climate which gives abundant opportunity for taking outdoor scenes successfully.

The architecture of Mediterranean lands with broad piazzas, shaded balconies and thick walls indicates an adaptation to the environment. The bungalows of southern California are characteristic. Outside of Europe the regions of this type of climate evidence its popularity by the relative density of their population. In Europe, in spite of the ease of life in this belt and its lack of the stimulating climate of the cyclonic regions, history shows the rise of many important civilizations in the Mediterranean region, such for example as those of ancient Greece and Carthage and the Roman Empire.

The warm temperate east-coast regions.—The climate of these leeward coasts in the temperate zone below 40° shows a big contrast to the west or windward coasts in the same latitudes. The temperatures are not unlike, but the rainfall comes more or less throughout the year with the maximum in summer, and there is no distinctly dry season. These regions, under the influence of the westerlies in winter, tend to get rain in summer from the development of low-pressure areas to the west of them which draw in the moisture-laden air from the oceans to their east. Thus these warm temperate oceanic regions are said to have a monsoon type of climate, the summer winds being more or less opposite in direction from what they are in winter.

The areas with this warm *temperate oceanic* or *temperate monsoon* type of climate include the cotton- and rice-growing regions of southeastern United States, much of China and Japan, the Paraná valley region of South America, Natal in eastern South Africa, and the southeast-coast region of New South Wales and Victoria in Australia. Central and northern China have cold winters owing to the continental influence of Eurasia, and in the southeastern United States sudden and extreme changes in temperature are frequent, especially in winter, but in the Southern Hemisphere temperature ranges are much narrower.

These differences in climate of the various regions of this type make corresponding differences in vegetation. All are characterized by forests, however, and in many cases the abundant rains cause swamps. These, where the temperatures are high, tend to invite diseases, such as malaria, and conditions are similar to those in equatorial forests. The valleys of central China with their rice, cotton, tea, and silk support a dense population. The Cotton Belt of the United States is the greatest in the world, and it is now beginning to develop its own manufacturing industries, while Natal and southeastern Australia each supports a large population.



Photos by courtesy of U. S. Forest Service.

Fig. 44.

Upper.—Cotton ginning day, Mount Hope, Alabama.
Lower.—Loading cotton at Mobile, Alabama.

The temperate arid interior or desert type.—The regions having this type of climate are found for the most part on plateaus in the interior of continents separated from the windward coasts by high mountains or distance. Consequently, they are characterized by extremes of temperature both diurnal and annual, by scanty rainfall and vegetation, and by sparse population. Except where irrigation is commercially possible or minerals are found, there is not much to attract any settled population. Sometimes, owing to their position on trade routes, considerable centers of commerce have grown up within these regions. (See Figs. 43 and 49.)

The largest regions of this type are in the interior of Asia, east of the Caspian Sea, and in western China; in North America, between the Sierra Nevadas and the Rocky Mountains; and in southern and western Australia. Other examples are northwestern Argentina in South America and the Kalahari Desert in South Africa.

The Climates of the Tropics.

The tropical monsoon regions.—While the above warm-temperate oceanic regions have a monsoon type of climate, the real *monsoon regions* are found within the tropics. This type of climate is best represented in India and Farther India (Indo-China), which are in winter under the influence of the dry tropical calm belt and the northeast trades. Also, the cold high-pressure area of Asia at that time causes the winds to blow outward from the dry interior of the continent. In summer, however, with the vertical sun over India a hot low-pressure area forms over interior Asia, and then the winds blow in from the oceans, particularly the Indian Ocean, thus bringing rain, especially to India where the high Himalaya Mountains force the air upwards, thus cooling it and producing heavy rainfall.

Other monsoon areas are northern Australia, the coast of the Gulf of Guinea in Africa, Florida and the Gulf Coast in the United States, and small areas in northern South America. None of them have the distinctly pure tropical monsoon type, however, that is developed in India, Farther India, and southern China.

The monsoons are the life of the people in southern Asia. Upon their regular appearance depends the success of their crops and, consequently, the support of their millions of population. The failure of the rains means crop failure, famine, and destitution. As a general rule the monsoon countries are very densely populated, as is indicated by the fact that in India, two-thirds the size of the United States, there live 300 million people.

Dry trade-wind deserts.—In the trade-wind belts of both hemispheres the winds have a motion towards the west as well as towards the equator. The result is that on the western sides of the continents in these latitudes there is but little rainfall, for the trade winds coming from dry continental interiors have only very little moisture and, as they are moving towards a warmer region, conditions are not favorable for precipitation. These areas merge into those near the tropics where the dry calms of high pressure prevail with their descending air currents which, getting warmer instead of cooler, create conditions decidedly against rainfall. So we have the world's greatest hot deserts in the Sahara of northern Africa, in Arabia and Persia in Asia, in Mexico in North America, on the west coast of South America, in Peru and Chile, in the Kalahari Desert in Southwest Africa, and the Great Australian Desert in Central and Western Australia.

Living conditions in these hot deserts are hard. Some wandering nomads with camels carry goods from place to place in the Sahara or Arabia, for example; others engage more often in banditry. In some scattered fertile areas, called *oases,* a small settled population is engaged in grain growing or cattle raising, and usually in cultivating the date palm. In other places, as in the goldfields of Western Australia or the nitrate mines of Chile, the mineral deposits with their opportunity for profit and employment give rise to a settled population. As a general thing, however, these regions are very sparsely inhabited or entirely lacking in population.

The tropical grasslands.—Towards the equator, however, these deserts of the trade-wind zone gradually merge into the tropical grasslands. The latter form a transitional area between the vegetationless hot deserts and the equatorial belt of dense forestry. The grass of these regions is due to a seasonal rainfall which varies from 10 to 15 inches on the edge of the desert to 70 or 80 inches at the margin of the forest area. The greater part of the year these areas are under the influ-

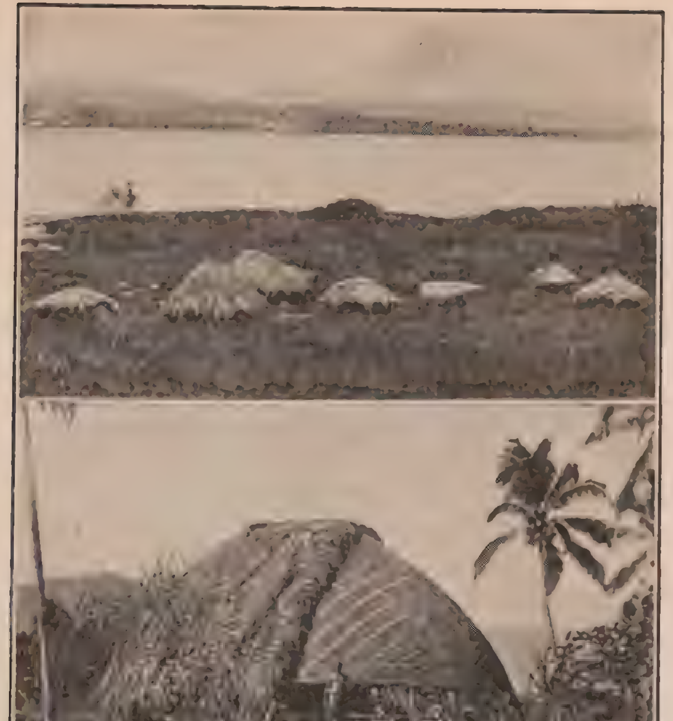


Fig. 45.

Upper.—Grass-covered huts of natives of equatorward margins of tropical grass-lands, near Mombasa, East Africa.

Middle.—Building a native house in the Samoan Islands. Note the framework, the thatched cover, and the cocoanut palm trees.

Lower.—Native dance in front of Samoan houses, Apia, Samoa.

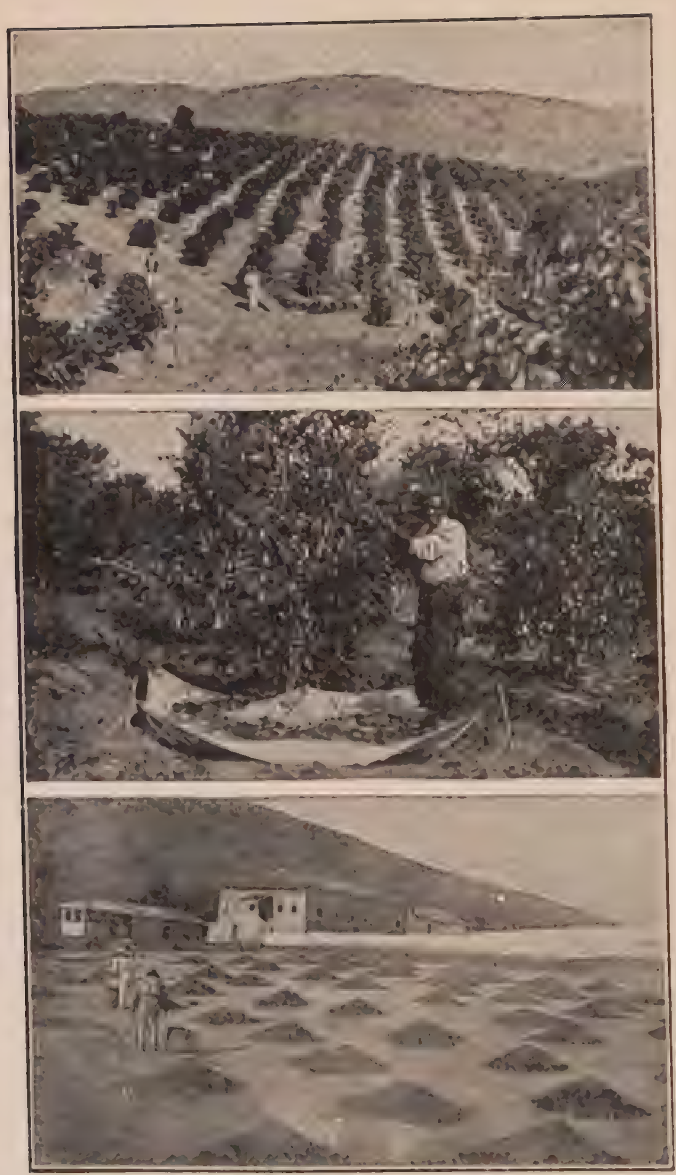


Fig. 46.—Coffee Growing in Brazil.

Upper.—Fields of young coffee trees.

Middle.—Gathering coffee, a work that can be done by young and old, women and children.

Lower.—Coffee heaped up ready for storing away, after being thoroughly dried.

ence of the trade winds, and hence lacking in rainfall. At the time, however, when the vertical sun passes poleward to the tropics, which it reaches at the time of the summer solstice, the equatorial belt of calms with its rising currents of air comes over and favors these grassland areas with a season of rainfall, owing to the cooling of the rising air currents of the equatorial calm belt. These rains make possible a heavy growth of tall grass but are not usually sufficient for forest growth.

This type of climate is therefore known as the savanna type, or sometimes the Sudan type, from the great grassland area extending almost across Africa just south of the Sahara. In fact, this African grassland area also extends southward in east central Africa not far from the Indian Ocean Coast, and then includes a broad belt in the southern part of tropical Africa extending to the Atlantic coast. Similar tropical grassland areas are found in northern Australia, western Madagascar, and in south central Brazil, Guiana, and Venezuela in South America (see Fig 45, *Upper*).

Most of these grasslands of the tropics are as yet undeveloped. But Southern Rhodesia in South Africa is becoming a great grazing country, and it is likely that stock raising will ultimately become a great industry in all these regions.

Moist trade-wind coasts.—Where the trade winds blowing from the ocean strike high mountains or rugged east coasts they bring abundant rainfall to the windward slopes of such mountains. These conditions prevail in the West Indies, eastern Central America, Guiana, and on the eastern coast of Brazil, for example. In these cases the warm temperatures and abundant and frequent rains cause a dense growth of vegetation. Sugar cane, bananas, and other tropical fruits are therefore produced with ease and profit.

The equatorial type of climate.—Over a belt extending about 10° in width on each side of the equator the equatorial belt of calms swings back and forth, as the sun makes its annual trip back and forth from the tropic of Cancer to the tropic of Capricorn. This belt of calms, as has been pointed out before, is a daily rain producer owing to the ascending and

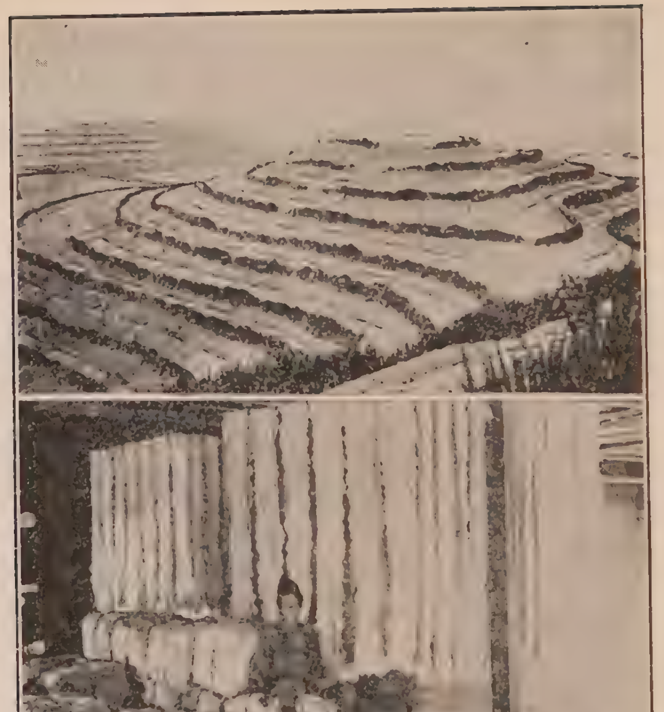


Fig. 47.

Upper.—Contour planting of young rubber plantations, Singapore Island.

Middle.—Drying sheets of rubber in crude rubber factory, Singapore Island.

Lower.—Ivory tusks brought from interior by natives, Mombasa, Equatorial East Africa.

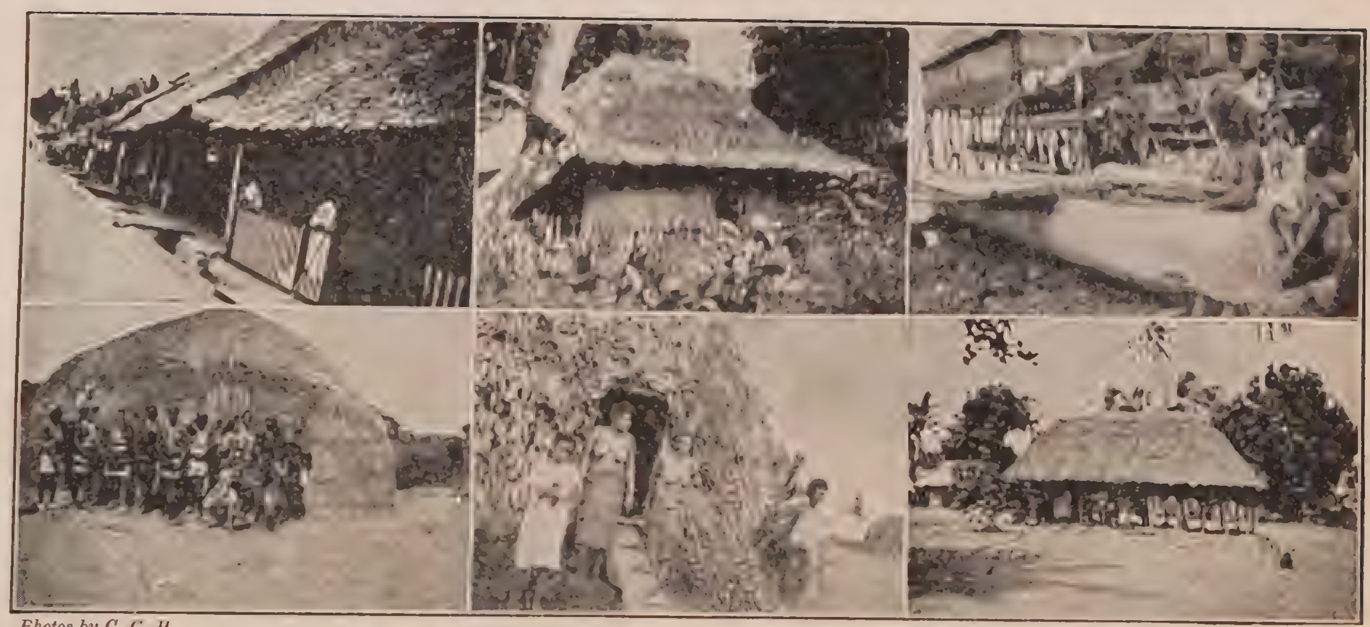
consequently cooling air currents. Twice during its annual journey the sun is vertically over the equator. This is at the time of the equinoxes, that is, in our fall and spring. These then are the rainy seasons in regions having the true equatorial type of climate. As the season lags somewhat behind the movement of the sun, the equatorial rainfall at the equator does not reach its maximum at the time of the equinoxes, but a month or so afterwards. Between these two seasons of maximum rainfall there are two periods when the rain, though usually not entirely lacking, is somewhat scanty. Thus regions with the equatorial type of climate have four seasons, two wet (April-May and October-November) and two dry.

The abundance of rainfall in these regions, together with the steady heat, produces the jungles and dense forest growth which constitute the characteristic natural vegetation of the equatorial belt.

So far the climate of most of these regions has proved unhealthful, particularly for white people. Development, however, is slowly advancing along the margins of the area, and further ability to control disease may bring into increasing importance this great source of timber and tropical products which the world's rapidly increasing population seems destined soon to need. Java's ability to support thirty-five million people under the administration of some 250,000 Dutch is a good illustration of the possibilities of such regions.

Mountain and Plateau Climates.

Varied climates of mountains and plateaus.—The chief characteristic of the meteorological phenomena of mountains and plateaus is variability. Highlands in the tropics have climates which differ from those of similar elevations in temperate zones. The climate of a mountain valley may be temperate in character while the summit area is frigid. One side of a mountain range may be drenched with frequent torrential rains while the opposite slope basks in daily sunshine. The major causes for the climatic variabilities of elevated lands are due to their (1) location, (2) altitude, (3) position in respect to winds, (4) area, and (5) character of surface. Since



Photos by C. C. H.

Fig. 48.—Primitive Houses in Different Climatic Regions.

Upper Left.—Village street in interior of Singapore Island. *Middle.*—A country house in Java. *Right.*—Native houses on piles in New Guinea.

Lower Left.—Zulu house and women, Natal, South Africa. *Middle.*—A mountain home in the Fiji Islands. *Right.*—A native Samoan house.

these factors have been considered, their effects on climate are only briefly discussed here.

Temperature influences.—An important feature of highlands is their influence on temperature. There is an average decrease of about 1° F. for each 300-foot increase in altitude. The rate varies according to seasons (being usually greater in summer than in winter); the loftiness of the region; and the character of the slopes and valleys, such as their grade, surface features and insolation. This change in temperature influences the distribution and activities of all forms of life. Especially in arid and tropical areas does the value of elevation stand forth with prominence. It brings rain to the deserts and temperate areas to the tropics. In other words, nature duplicates on the basis of altitude the character of life encountered by a change in latitude. Thus, we may find in the tropical zone, on mountain and plateau slopes, first, dense tangles of equatorial trees, vines, and underbrush with cultivated areas of bananas, rubber trees, cocoanut trees, cacao trees, and other tropical plants interspersed here and there; with an increase in elevation, subtropical plants appear, including coffee plants, citrous fruits, cassava plantations, and numerous varieties of deciduous trees; as the distance above sea level is increased there are temperate plants, such as corn, rye, barley, and potatoes, and deciduous and coniferous trees; and at still higher altitudes, polar conditions may prevail, characterized by tundra flora and fields of permanent snow and ice.

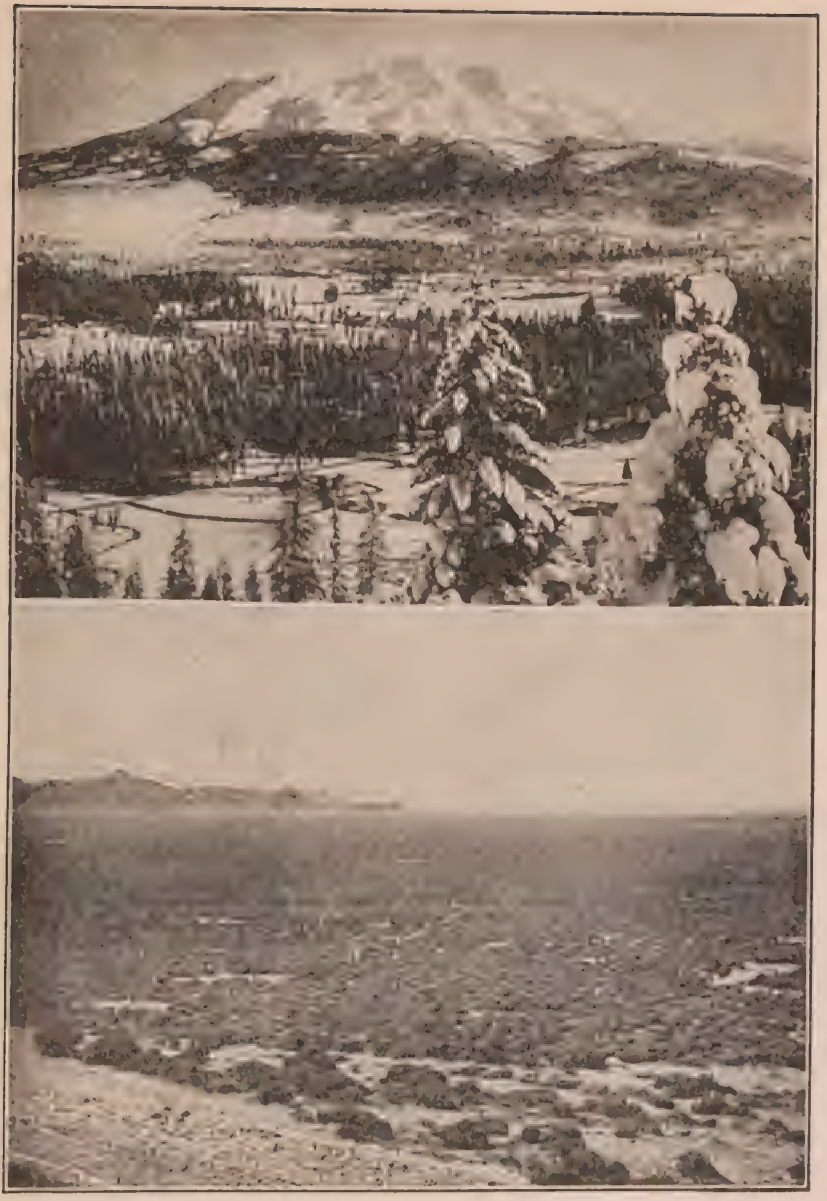
The temperature does not always decrease with an increase in altitude. It sometimes happens that temperature decreases from summit to valley rather than from valley to summit. This is known as *inversion of temperature.* It takes place in narrow valleys, in enclosed basins, on piedmont areas, and in plains adjacent to isolated peaks. The inversion of temperature depends not only on topography but also on the atmospheric conditions. In times of calm, clear weather with high barometric pressure, inversion of temperature is experienced. When the air is calm, especially at night, the cold layers descend on the basis of their own weight to valley bottoms or adjoining lowlands, a movement which is sometimes referred to as air drainage.

This often makes the slopes better for fruit growing than the adjacent valley, which is in greater danger of frost ruining the crops. Since the radiation by night cools the air near the ground there is no circulation. Thus the air is steadily dropping in temperature, and frost may result. This cooling will continue until some definite winds bring about circulation.

The geographical importance of inverse temperature is thus of no little significance. It explains why homes are not built on the valley floors in some regions, but rather on the terraced slopes or elevated portions of the valley; and why mountain, plateau, or hill slopes are preferred—up to a certain elevation, which is governed by altitude, exposure, and so on—for the cultivation of plants, easily destroyed by frost. In various parts of California, oranges and grapes are grown on the piedmont slopes while the crops more resistant to low temperatures, such as alfalfa and barley, are grown on the lower margins or plains. Coffee plantations, for the same reason, are invariably located on the high ground (see Fig. 46).

Rainfall influences.—The distribution and amount of rainfall on highlands depend in part upon their (1) elevation, and (2) position in respect to winds. Rainfall generally increases up to an elevation of about 7000 feet above sea level, and then it decreases. At great elevations the precipitation is in the form of snow.

The position of the *snow line,* the limits of the eternal snow, depends not only on rainfall, but also on temperature. However, rainfall seems to be the dominating factor, as the wettest slopes always have the lowest snow line, even when it is the warmest slope. The snow line descends to 15,000 feet on the southern slope of the Himalayas which is subjected to the monsoon rains, while, on the drier, northern slope, the snow line is at an altitude of 19,000 feet. The same is true of the Alps. In the western Alps, the snow line is lower than in the drier eastern Alps. The snow line is one of the most important geographic boundaries of highlands. It separates, with striking abruptness, two regions which are physically as



Photos by courtesy of the U. S. Forest Service.

Fig. 49.—Mountain and Desert.

Upper.—Mt. Shasta.

Lower.—South end of the Great Salt Lake Desert from the southwest of Simpson range.

well as biologically different. It distinguishes to some extent the habitable from the nonhabitable areas of highlands.

The precipitation on mountains and plateaus, as already pointed out, is decidedly variable. It is very seldom that two slopes have the same amount of rainfall. This is one reason why mountains are recognized as climatic barriers. The deserts on the leeward side and the humid areas on the windward slopes of the Rocky Mountains, the Himalayas, and the Andes, are worthy illustrations.

Wind influences.—A varied relief is always associated with a variability in atmospheric pressure. Since air movement depends upon the pressure of the air, it must follow that winds are frequent and potent features of highland climates. Nearly every one expects to find a breeze blowing on mountains and plateaus, and in most cases these expectations are fulfilled. The more common types of winds in the mountainous regions are the valley breezes.

Another type of wind, one of considerable interest and importance is known as the *foehn,* and also as the *chinook* or *snow-eater.* It is found in all mountainous parts of the world but has been studied most intensely in the Alps and on the eastern slope of the Rocky Mountains.

A foehn is a warm, dry wind which blows from the mountains to the plains below. The wind often comes shortly after the beginning of spring, following a period of severe, cold, and calm weather. Its presence is known by the sudden melting of the snow; by the rapid rise in temperature (from 14°F. to 68°F. is not unusual); and by the dry air. Avalanches may start down the slopes; and streams rush in torrents as they are fed by the rapid melting of the snow. It has been said that people of the Alpine hamlets, living in the path of the foehn "retire within their doors, the flocks and herds are hastily driven in, and fires extinguished—for the air is so dry that a spark might cause conflagration." However, there are many beneficial results derived from the influence of the foehn, such as an early removal of the snow, which makes it possible for stock to graze on the uncovered grass, makes agriculture possible in valleys which are so located that they receive very little heat from the sun, hastens the ripening of cultivated fruits, especially grapes, and extends the polar limits of cereals (for example, in eastern Canada the northern limit of cereal production is in the latitude of Bordeau, but in the west, cereals are grown as far north as Lake Athabaska at the eastern foot of the Rockies in latitude 60° north, owing to the influence of the chinook winds.

The foehn is primarily due to the difference in atmospheric pressure, that is, the movement of air from a region of high pressure to one of low pressure. But it is also influenced by the relief of the land. Air, moisture-laden, is forced up over mountain ranges; condensation takes place either by the cooling of the air coming in contact with the colder mountain top, or by adiabatic cooling of the ascending air, or both; and then the air descends on the other side of the mountain as warm, dry air. Thus it has a high evaporation power, and melts the snow in its path and greatly increases the temperature of the region under its influence.

Other violent and often destructive winds, associated with mountainous regions are the mistral of Mediterranean France and the *bora* of the Adriatic. They are due to the presence of a high pressure area over northern Europe, which frequently causes northerly winds to penetrate to the Mediterranean. They are cold winds sliding down the steep slopes of the highlands to the north and frequently destroying the cultivated plants in the lowlands.

CHAPTER VII

THE SEASONS AS GEOGRAPHICAL INFLUENCES

The Nature of Seasons and Seasonal Changes.

Seasons in middle latitudes.—"To everything there is a season, and a time to every purpose under the heaven," saith the Preacher, and this suggests the literal meaning of the word "season," which signifies that which comes or arrives. In this general sense the term is more or less synonymous with "time." Thus we have the football season, the social season, the strawberry season, the tourist season, the harvesting season, the unemployment season, and so forth.

As a geographic factor, however, most of us will think of a season as one of the four divisions of the year: spring, summer, autumn and winter. In this latitude we generally consider March, April and May the spring months; June, July and August the summer months, and so on. In the south temperate zone, however, the seasons are reversed; March, April, and May being autumn months, and June, July, and August winter months. An instance of the economic importance of this reversal of seasons in the southern hemisphere is the occurrence of the harvest in Argentina during the winter of the northern hemisphere, thus enabling Italian laborers to go by fast steamers to Argentina for the harvest, and to get back home in time for the summer harvest there.

In both the temperate zones the distinction between seasons is based on temperature, summer being the warmest three months and winter the coldest three, the other two seasons being in the nature of transitional periods. Frequently, however, we speak of spring as beginning the 21st of March, summer the 21st of June, autumn the 22d of September, and winter the 22d of December, the equinoxes and solstices being considered the dividing points of the seasons. Finally, as the season really lags behind the movement of the vertical sun, we often find the calendar year divided into quarters: January-March, April-June, and so on. This division of the year is much used in the statistical publications of the United States Government.

Seasons in other latitudes.—It must not be supposed, though, that all parts of the world have these same seasons, the same arrangement of seasons, or even the same number of seasons. Neither is temperature always the guide to seasonal differences. Within the tropics, for example, " seasons " in the sense in which we use the term in the temperate zone do not exist. There the temperature is so uniform throughout the year, while rainfall is so variable, that the seasons are based on rainfall. Thus they have rainy seasons and dry seasons, the most important climatic phenomenon of the year in the tropics being the rainy season.

In the polar regions, in contrast to the tropics, there is no really warm season, although the terms " summer " and " winter " are used. The polar summer is really only a modified winter, the Antarctic summer being colder than that of the Arctic region. Ward gives the following mean temperatures for certain high northern latitudes:

Latitude	70°	75°	80°	85°
January	–15.3°	–20.2°	–26.0°	–36.6°
July	45.1	38.1	35.6	32.5
Year	12.7	5.5	–0.6	–6.2

None of the above temperatures is high enough to permit the growth of cereals for example, so the term " summer " as applied in polar regions must be understood to mean a season of a somewhat different type from the one we are accustomed to associate with the word.

Seasons in polar regions.—As a matter of fact, light and darkness and the length of day give a better basis for distinguishing the seasons in polar regions than either temperature or precipitation. The periods of six months day and six months night in the year, found only at the poles, gradually diminish towards the polar circles where continuous light lasts only 24 hours and continuous darkness the same length of time.[1] About half way between the pole and the polar circle, periods of continuous darkness and continuous daylight last about four months each, while in latitude 70° these periods are about two months each. So we may say that the seasons of polar regions vary in length with latitude and are characterized by periods of continuous daylight and continuous darkness. These two periods are separated by others in which day and night alternate.

Taking 75° N. lat. as typical of polar regions we find four seasons: winter, with continuous darkness; spring, with day and night alternating, but with the days growing longer; summer, with continuous daylight; and autumn with day and night alternating, but with the nights growing longer. Seasonal changes in polar temperatures and precipitation may be seen on the charts for Point Barrow, Alaska, and for Victoria Land (see Fig. 54).

Causes of changes in seasons.—This changing length of day and night as one goes from the polar circle toward the pole is only the culmination of the increasing relative length of day and night from equator to poles, which, by disturbing the balance between the gain and loss of heat, is one of the reasons why seasons differ so much in the tropics from those in the temperate zones, or from those in the polar regions. This change in the relative length of day and night from equator to poles is due to the inclination of the earth's axis and the revolution of the earth around the sun as explained in Chapter IV (see also Fig. 50).

Other reasons for the change of seasons, due to the same causes, are the greater surface area to be warmed by a given amount of sunlight (see Figs. 14 and 33), when these ray's strike the earth more obliquely, as they do with increasing latitude, or at places in the same latitude as the vertical sun journeys towards or into the opposite hemisphere. Within the tropics the sun is always vertically overhead at some place, which accounts for the great uniformity of temperature throughout the year at any given place in those regions.

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[1] Even at the poles, mere points, the statement that they have six months of darkness must be taken as theoretical only. As a matter of fact, owing to the sun's diameter being so much larger than that of the earth, and also to the air's properties of reflection and refraction of light, the period of actual darkness even at the poles is only about 4½ months, leaving about 7½ months of light.

Importance of seasons and seasonal changes to life.—Probably no other geographic factor exceeds the seasons in immediate and everyday importance to life. In the temperate zone we are all familiar with the dying of the grass, flowers, and other vegetation in the autumn, their lying dormant during winter, and their return to life, vigor, and beauty in the spring. We see the leaves of deciduous trees fall in the autumn and, consequently, commonly speak of that season as the fall. We know something about the effect of the seasons on the growth of seeds and fruits and about the various ways by which plants store up food or water to keep them alive, during the winter or dry season, until the return of the season of growth.

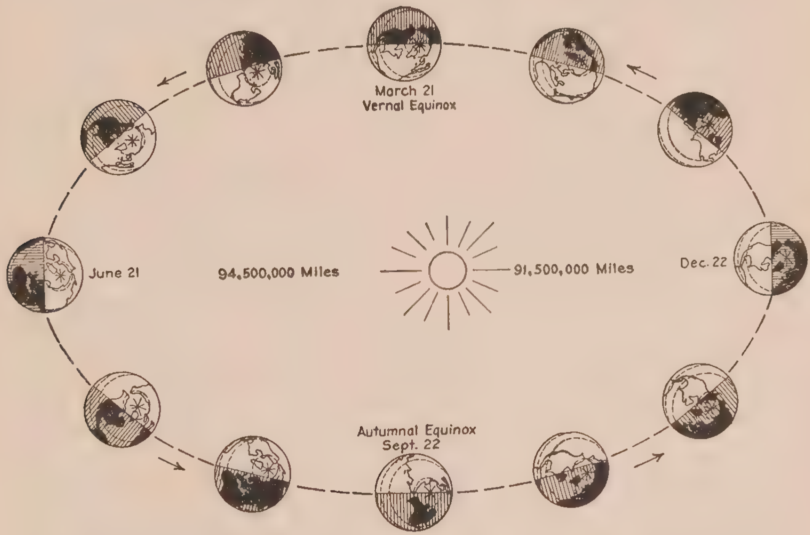


Fig. 50.—Position of the earth in its orbit at different seasons. Imagining his point of observation to be above the north pole, the observer can note the reason for the changing length of night and daylight as the earth moves around its orbit.

We have seen squirrels burying nuts for the same reason, and have at least heard of the fact that bears, rodents, snakes, and various insects hibernate during the winter. We have seen great flocks of wild geese, ducks, or birds on their north or south migrations in response to the change of seasons. We have read of the seasonal migrations of fish and have learned that many animals take on fat at the approach of winter, and that many shed their winter hair or fur or are sheared of their wool when the winter is over. And we know the utility or value to man of wool, fur, lard, honey, and other products of the seasonal efforts of animals to protect themselves from winter.

College students grow enthusiastic over football in the fall; skate, toboggan, or attend basket ball games in the winter; watch the baseball games in the spring; and in the summer "hike" to mountains, lakes, or seashore, with perhaps not a thought of the seasonal influences upon their recreation. The Salvation Army and other social workers note the return of the laborers to town upon the coming of winter; and are familiar with the seasonal character of employment in many industries, and resultant problems of unemployment affecting thousands of working men and women in all our industrial cities. The farmer knows well the influence of the seasons upon all his work, the planting or harvesting of his crops, the feeding or housing of his live stock, and the marketing of his products. The milliners, dry goods and hardware merchants, and clothiers buy their stocks according to the rhythm of anticipated seasonal demand. The head of the household watches with misgiving the mounting of his coal, gas, and electric-light bills in the winter, while the housewife views with equal alarm the distressing effects of coal dust, soot, and smoke upon her bedding, rugs and draperies.

Relation of seasons to health, energy, and civilization.—Health and energy, also, vary with the seasons. People generally seem to have the best health in the autumn. October is perhaps the best month. Then more people feel like working hard. Dr. Ellsworth Huntington of Yale University says: "Headaches, colds, indigestion, and other minor illnesses are fewer than at other seasons; there are also fewer serious illnesses, so that the doctors have less than usual to do, and the number of deaths is less than at any other time of year." His view is, then, that as the cold season comes on workmen accomplish less, ill health is more general, physicians are busier, and deaths increase, until general efficiency and health may be as much as a fifth lower by the middle of winter. Then as warm weather returns in spring, conditions improve until health and energy in general may be almost as good again by May or June as they were in the fall. Finally with the hot weather of summer, conditions of health and energy are again at a low ebb, although the diseases most prevalent are then not usually the same as in the winter. Mental activity seems also to vary from season to season, being stimulated most in weather somewhat cooler, however, than that most favorable to physical energy. Much of the energy, thrift, and industry characteristic of the temperate zone, particularly of the Northern Hemisphere, is generally considered due in large part to the influence of the seasons.

The variations of temperature from season to season, extreme though they are, in the temperate zones are evidently better for human progress than the monotonously uniform heat of the tropics or the continual and depressing cold of the polar regions. In fact, one important reason why the temperate zones deserve their name is that in their physiological effects on man they are intermediate between the tropical and the polar regions. As Ward says: "In the temperate zones the organs of the body act more equally than in the warmer or the cooler latitudes." And health and energy go together in contributing to civilization. In the temperate zones man meets the seasonal cold of winter by dressing warmly, heating his houses, and so forth; and the cold, therefore, commonly acts as a healthful stimulant to bodily and mental activity. In summer then, when conditions of life are usually easier, and nature is more abundant with supplies, man finds it necessary but easier to provide food, clothing, and shelter for winter, the time of natural scarcity. This planning and providing for the future season's needs requires regular thought and effort. Consequently, the differing and changing seasons of the temperate zones must be credited with a considerable contribution to the physical, mental, and industrial development which underlie the civilization of our greatest nations to-day.

Seasons in Tropical Regions.

Seasons of the equatorial type of climate.—Since the tropical regions are characterized, not only by uniformity of temperature throughout the year, but also by variability of rainfall at different times and in different places, it follows that rainfall is the natural basis for distinguishing the tropical seasons. On this basis of the amount of rainfall, or the time at which it comes, we find some places with two rainy seasons and two of less rain, during the year; some places with one wet and one dry season; and others where it rains very little or not at all, at any season.

The great cause for this variability of rainfall within the tropics is the swing northward or southward of the belts of calms and planetary winds with the apparent motion of the sun from tropic to tropic. Since the equatorial belt of calms is a low-pressure area of rising and consequently cooling air, it follows that it is a rainy belt, not that it rains there continuously, but that it rains with sufficient regularity every day or every afternoon that social engagements are commonly made for "after the shower." One striking thing about this equatorial rainy belt of calms is that it moves northward or southward following the vertical sun. Now the sun shines vertically over the equator twice during the year, that is, at the time of the equinoxes. Likewise, twice during the year the vertical sun is over one of the tropics, that is, 23½° north or south of the equator. This results in regions with the equatorial type of climate having four seasons, two rainy and two (so-called) dry seasons. In fact, all four are rainy, but at two of them there is likely to be a maximum of rainfall. These two would be at the time of the equinoxes were it not for the fact that the north and south migration of the belt of equatorial calms lags somewhat behind that of the vertical position of the sun. This *lag behind* is characteristic of seasons, however, in all zones. For example, in the United States, as we know, the warm period of summer comes usually not right at the 21st of June, the longest day, but somewhat later.

Owing to this lag behind, the equatorial belt of daily rains does not reach as far from the equator as the vertical sun travels, but affects a region about 10° or 12° wide on each side of the equator. Places on the northern or southern margin of this belt usually have but one season of maximum rainfall. The farther one goes from the equator the more the seasonal distribution of rainfall in these regions is complicated by trade-wind influences, monsoons, or other causes. In South America, for example, east of the Andes, the distinction between the rainy and dry seasons is often scarcely perceptible. The temperature ranges of the seasons in the equatorial belt are only a little if any greater than the daily range. At Equatorville, on the Congo in Central Africa, the mean annual range is but little over 2°, while the mean daily range is about 14.5°. Such conditions have caused the saying that " night is the winter of the tropics." It seems hard to believe, but there is much danger of taking cold in the tropics. The danger of becoming chilled is greatest when the cool winds blow, during rains, and in the cooler hours of night. There are also many tropical diseases, as, malaria, yellow fever, and the sleeping sickness. The danger from all these is greatest during the rainy season.

The always-hot, always-wet climate of the equatorial regions causes a luxuriant but rank growth of vegetation. The forests are the home of a sparse and backward population of natives commonly stunted both in body and mind, such as the Indians of the Amazon valley and the pygmies of the Congo, who live chiefly by hunting and fishing. As the rainy season causes floods which drive out much of the game upon which the natives depend, many of their religious ceremonies include prayers for a long dry season.

These regions of rainy and hot seasons are *unhealthful for white people*. If they escape the tropical diseases, the constant heat and moisture, day after day, month after month, season after season, the year around, with never any stimulus from a cool season, eventually bring about degeneration.

Evaporation from the body is reduced by the excessive humidity, the blood tends to become diluted, and sooner or later, the white man succumbs to tropical anæmia unless he seeks relief in a climate with a cooler season. Some relief may be obtained by going to tropical mountain stations, many of which have become noted as health resorts, but such can never equal the temperate-zone climate for they do not have the seasonal changes.

On the plateau of Ecuador, eight or ten thousand feet above the sea, Quito, almost on the equator, has an average temperature of only 55° and an annual range of less than one degree, and Englishmen thinking of the balmy spring days of England call Ecuador the "Land of Eternal Spring." But the nonseasonal character of tropical mountain climates, the so-called "perpetual spring," however pleasant it may seem for awhile, is not the best for the white man physically and mentally. Tropical climates which are temperate because of altitude can hardly replace climates with stimulating seasons such as those of temperate zones. Nevertheless, the ability of the whites to live in the tropics is an important matter, for it involves the problem of the control and utilization of the tropics with their great and ever more-needed resources. Consequently, properly selected hill stations will doubtless always be necessary to the comfort, health, and success of white people who have to live in the tropics, and especially to white women and children.

The following diagrams illustrate graphically the uniformly high temperatures and the variable rainfall of different seasons at typical places in the equatorial region. Note the lesser rainfall and the lower monthly temperatures at Quito of which the elevation is 9350 feet above the sea, as compared with New Antwerp, 1230 feet, and Ocean Island, 84 feet (see Fig. 51 and Fig. 52).

Seasons of the Trade-Wind Belts.

Seasons of the tropical grasslands.—On either side of the true equatorial region is a somewhat narrow belt in each hemisphere which is under the influence of the equatorial belt of calms when the vertical sun is near the tropic of that hemisphere, but which is dominated by the trade winds the rest of the year. Such regions have a rainy season when the equatorial belt of calms prevails, but a dry season when the trade wind blows over them. The rainy season is therefore shorter than the dry season, for the vertical sun is in the vicinity of the tropic of that hemisphere naturally a shorter time than the period required for its journey across the equator, and on to the tropic of the opposite hemisphere. The rainy season lasts from three to five months, while the dry, almost rainless, season continues from seven to nine months. In the Northern Hemisphere the rainy season of this tropical grassland or savanna type of climate normally begins in May or June and lasts till September or October. South of the equator the rainy season continues usually from November until March.

The long dry season of these regions and the (normally) relatively lesser rainfall than in equatorial regions prevents dense forests, but permits a luxuriant growth of grass with some scattered patches of trees. Consequently the native peoples, more advanced than the population of the equatorial rain forests, support themselves largely by raising flocks and herds. Many of these pastoral peoples become nomadic in order better to find and utilize the pastures for their stock. In some places, however, usually where irrigation is possible, settled agriculture is practiced. Where irrigation is not possible, crops are planted only in the rainy season. The long dry seasons and the varying amount of rainfall in the rainy season, as well as its more or less uncertain length, have retarded agriculture in these regions, but the *llanos* of Venezuela, the *campos* of Brazil, and the Sudan of Africa, together with a large area in northern Australia, give promise for the future.

Timbuktu in the African Sudan and Bulawayo in Southern Rhodesia are typical examples of places having one wet season followed by a longer, almost dry season. The seasonal distribution of rainfall and temperature for each of them is illustrated in the following graph (see Fig. 52).

Seasons of moist trade-wind coasts.—While the trade winds are generally dry winds, yet where highlands intercept them and force them upward, thus cooling them, they bring rain to the windward side. Such windward slopes and coasts may have their rainfall distributed rather evenly throughout the year, as does Hilo in the Hawaiian Islands, for example, or they may have a seasonal rainfall. This usually tends to be greater during their so-called winter season, that is, when the vertical sun is in the opposite hemisphere; but in other places

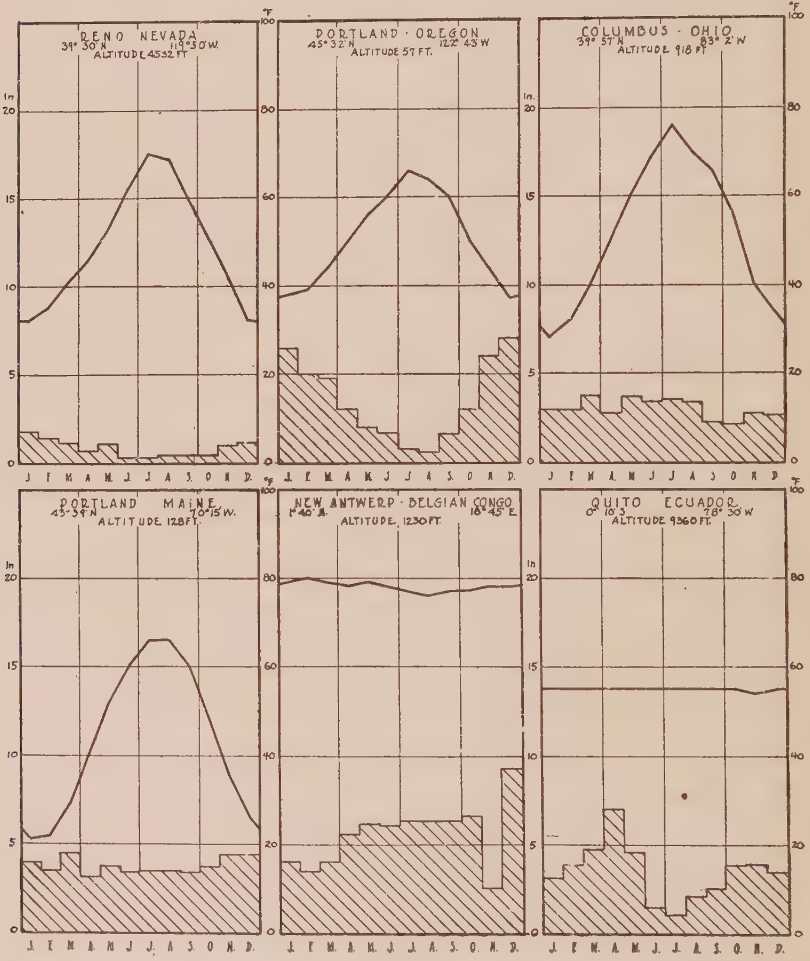


Fig. 51.—**The seasonal distribution of temperature and rainfall at specific places.** The height of the hatched areas indicates the rainfall, and that of the darkline curve the temperature, by months.

the rainier period may come in the summer months, as on the eastern coast of Brazil south of the equator where in winter the trades are offset to some extent by the cold air blowing outward from the high-pressure area in the colder interior. Rio de Janeiro, illustrated in the foregoing diagram, is a good example of this.

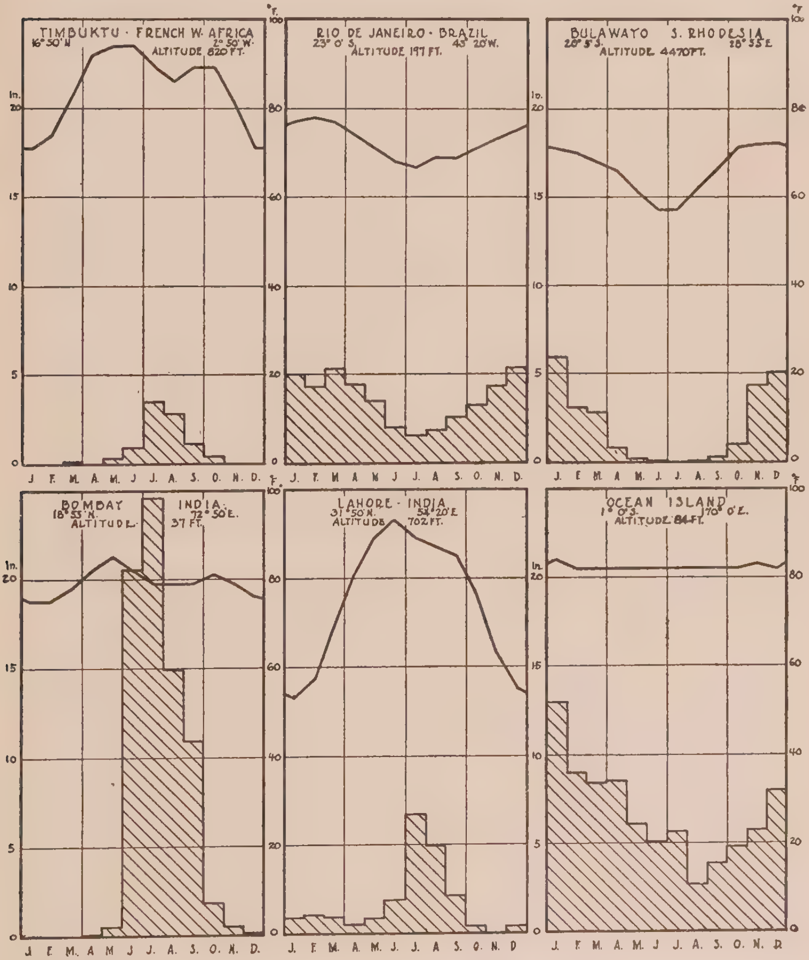


Fig. 52.—The seasonal distribution of temperature and rainfall at specific places. The height of the hatched areas indicates the rainfall, and that of the darkline curve the temperature, by months.

Some regions of this type, located so as to be affected alternately by the trade winds and the equatorial rainy belt of calms, may have four seasons, one rainy season when the sun is just overhead, another when the vertical sun is farthest away, and short, less rainy seasons between. Regions having the trade-wind influence are more or less subject to hurricanes in the late summer or early fall. These often cause great dam-

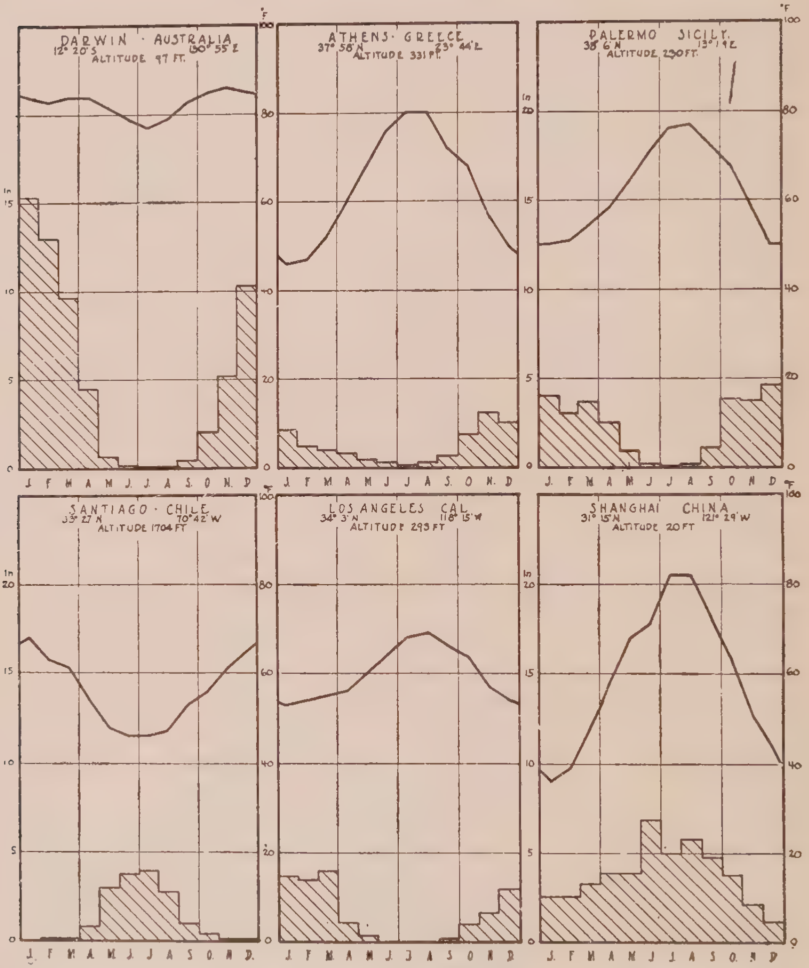


Fig. 53.—The seasonal distribution of temperature and rainfall at specific places. The height of the hatched areas indicates the rainfall, and that of the darkline curve, the temperature, by months.

age to crops and to the loosely built houses of the natives.

Tropical monsoon seasons.—Where the trade winds are regularly interrupted, even to the extent of reversal in direction, by seasonal differences of temperature over large land areas which become greatly heated during the summer months, we find the tropical monsoons. These regions like the tropical grasslands have hot, rainy summers, and dry, warm winters;

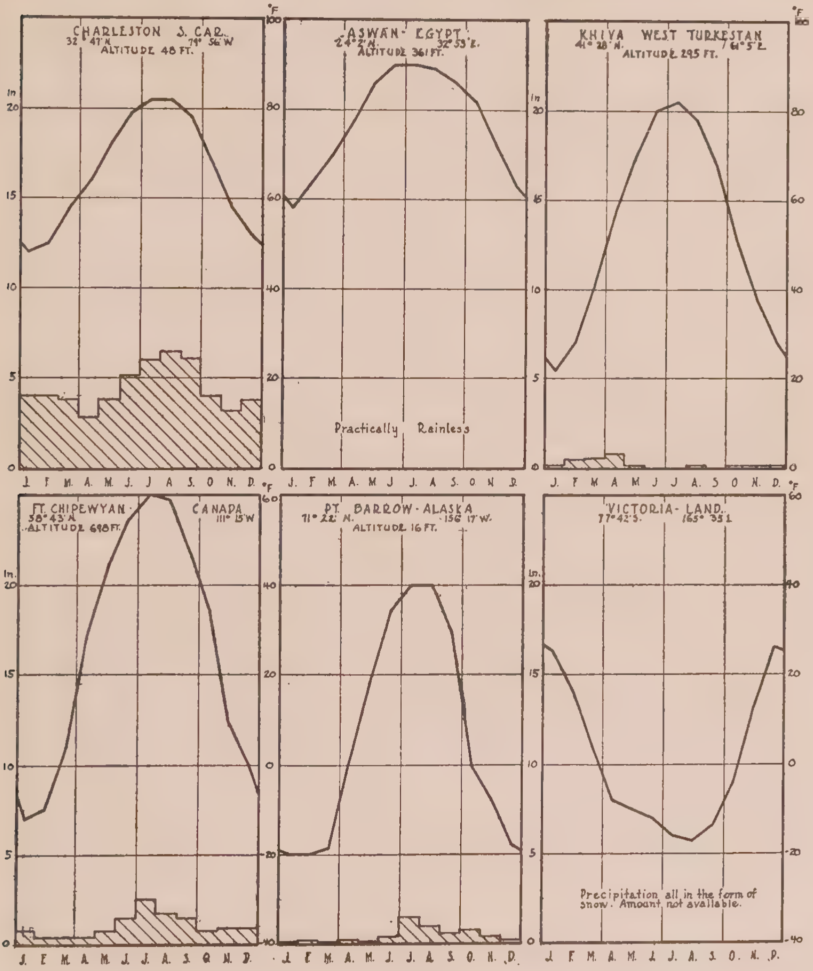


Fig. 54.—**The seasonal distribution of temperature and rainfall at specific places.** The height of the hatched areas indicates the rainfall, and that of the darkline curve, the temperature, by months.

but their rains are caused, not by the regular swing of the equatorial belt over the trade-wind area, as in the grassland type, but by the reversal of direction of the trade winds which, turning thus to blow from the equator (see Fig. 38), tend to become cooled, which tendency culminates in heavy precipitation when these winds ascend the highlands.

The term " monsoon " comes from an Arabic word meaning " season " and in India in the typical monsoon region the rainy season, from June to October in most of the country, is commonly called " the monsoon season," which is wet, hot, and oppressive. The hot dry season comes from February to May, while the land is heating. A third cool season (winter) with very little rain is recognized from November to January, while the normal trade winds are blowing. In the Southern Hemisphere, of course, the periods of the monsoon seasons are reversed. The dry season in monsoon districts is much drier than either of the two so-called dry seasons of the true equatorial regions. Consequently the dense populations of India, for example, are particularly dependent on the rainy season for their crops. Typical monsoon seasonal rainfall is illustrated in Figs. 52 and 53.

Seasons in trade-wind deserts.—These regions dominated either by the tropical calm belts of high pressure which are not conducive to rainfall, or by the trade winds, which normally are dry winds, are thus doomed by nature to lack of rain. They have a hot season when the sun is nearly overhead and a cold season at the opposite time of the year (see Fig. 54, Aswan, Egypt). During the latter (winter) season the climatic belts have swung so far toward the other hemisphere that the poleward edge of the desert may be touched by the westerly winds and thus get a slight rainfall. In the hot summer, on the contrary, the margin of the desert next the grasslands may come under the influence of the equatorial rain belt and so get a little rain. At the periods of equinoxes, however, during what are called the spring or autumn seasons, they ordinarily get no rain. This then gives these regions four seasons; two dry, and two others possibly not so dry.

There are usually but few clouds by day and the sun heats the vegetationless soil, while the cloudless nights favor rapid radiation of heat, so that it is likely to be cold at night. The seasonal character of what scant rainfall there is depends upon the location of the station. For a short time after the rain some plants spring up, soon to die, however, for lack of water. Along the margins of some deserts during the so-called rainy season some pasture may be found, thus favoring seasonal migration of pastoral tribes or nomads. The seasonal and uncertain nature of pasture also gives rise to raids on adjacent agricultural lands. Warlike tribes from the Sahara have many times invaded Egypt or the Sudan. Some oases support small populations of more settled peoples and some miners are found in deserts, but in the main the people are either nomadic or engaged in the caravan trade (see Fig. 43).

Seasons of the Temperate Zone.

Temperate deserts.—The desert areas of the temperate zones resemble the trade-wind deserts in lack of rainfall but differ from them particularly in that they occupy plateaus, for the most part, in the continental interiors, and consequently have a distinctly cold season. Even where oases are found in temperate deserts, or where irrigation is possible, or where dry farming is practiced, agricultural operations must stop during the winter. In tropical deserts, so far as temperature is concerned, the growing season is continuous. The scanty rainfall of the temperate deserts comes mostly in summer and the seasonal range of temperature is high. (See graphs for Reno, Neb. and Khiva, W. Turkestan, Figs. 51 and 54.)

Temperate grasslands.—The arid regions of the middle latitudes frequently merge through transitional semi-arid areas into the grasslands. These, like other temperate-zone regions, have the usual four seasons characteristic of those zones. As the social evolution of these grasslands develops, man tends to progress from hunter to stock raiser, and later to agriculturist where rainfall is sufficient. In much of this area grazing is still the dominant industry, and many examples may be found there of the necessity of seasonal migrations of pastoral nomads. In Turkestan shepherds follow the rainfall when it occurs at different seasons in the steppes. In Mongolia groups of natives collect in protected valleys in winter, but scatter in summer, better to take advantage of every possible water-hole or grass patch. Similar examples may be cited among the llaneros and gauchos of the llanos and pampas of South America. In all these regions the seasonal extremes of temperature characteristic of continental interiors are found.

Other temperate-zone regions.—Except in regions with the Mediterranean type of climate, with mild temperatures but wet winters and dry summers (see Fig. 47), the warm temperate east-coast or temperate-monsoon areas with maximum summer rainfall (see Fig. 53, Shanghai, and 54, Charleston, S. C.), and the cold temperate climates with their long, cold winters and short, cool summers (see Fig. 54, Ft. Chipewyan, Canada), the other temperate-zone areas have similar seasonal distribution of temperature and rainfall (see Fig. 53) and to a large extent similar industrial development.

Some Illustrations of Seasonal Influences on Industry and Trade in the United States.

Seasonal nature of all industries.—While industries differ greatly in the extent to which they are affected by seasons, it may be said in general that almost all are seasonal to some extent. It is hard to find a trade that does not have dull periods at more or less regular intervals. Agriculture of course is a classic example, but the shoe trade, the textile industries, the iron and steel industry, slaughtering and meat packing, even the automobile industry, all have regular intervals of slack time, to say nothing of those due to industrial depressions (so-called) which happily come at longer intervals.

The peaks of business are all right with nearly everybody, but the slack times have no appeal to the manufacturer or merchant and are most distressing to the working classes, thousands of whom, dependent on weekly wages, thus find themselves, unwillingly but regularly, forced into the great army of the unemployed.

It is not to be supposed that all such fluctuations are caused by the geographical change of seasons. Man is a free agent capable of choosing his course of action in many, perhaps most, cases, so he must take his share of the blame for many industrial and social maladjustments, for much of the changing demand and style and other factors that influence the ups and downs of business. However, the regular seasonal periodicity of many of the curves showing the progress of certain lines of industry and trade through the years is so striking that, even after eliminating the human factor as far as possible, it seems reasonably certain that the geographical seasons have considerable to do with the matter.

Agriculture.—Farmers usually do not depend entirely upon their regular labor force or "help" to carry on all the extra work which is necessary at certain seasons such as harvesting. At such times they employ additional workmen, if they are available. For this they must utilize largely the casual unskilled labor. As an illustration of the extra demand for farm labor during the first half of the year the following figures from the United States Employment Service in 1918 are suggestive:

Calls for Farm Labor by Months.

January	98
February	1,296
March	8,784
April	18,458
May	23,081
June	69,577
July 1–15	23,089

These figures are for the country as a whole, but the seasonal demand for farm labor is different in various geographical regions. In New England, for example, for the first half of the year considered, it is greatest in April, while in the winter wheat belt the greatest demand comes in June. In fact, the greatest single farm demand for casual labor in the United States is for the harvesting of winter wheat. In 1920 the United States Employment Service directed 53,072 harvest hands in the wheat belt alone. The harvesting in the central wheat belt annually requires the services of more than 100,000 men from other states.

The harvesting season differs somewhat from south to north. Normally it begins in north central Oklahoma about the first week of June, in southern Kansas about June 15, in central Kansas some ten days later, and the north central and northwestern section in the first week of July. Thus it is possible to use many men who start in the south and work northward as the harvest progresses. In 1928 the farm labor division of the federal government recruited for seasonal harvesting and directed to general farm work 559,571 men.

Of course the seasonal nature of agricultural work cannot be avoided, but the problem of providing information and transportation is one that can be worked out to the greater advantage of the casual workers, and the utilization of such in other industries at times when there is no demand for them on farms can help towards solving the general unemployment problem. The fact that great basic industries like agriculture and railroad construction are dependent upon migratory workers indicates the importance of solving the problem of the unemployed casual workers in winter, the season when there is least for them to do at present. Now, the winter finds these men drifting into the cities, depending on odd jobs or charity, and often increasing the crime wave.

The lumber industry.—Some two hundred thousand men are employed in this country as lumbermen, raftsmen, and woodchoppers. Most of the timber is cut in the winter months. Many of these men work in the wheat belt in summer. Others could be utilized in other farm sections, thus tending to equalize the supply and demand for workers of this class throughout the year.

In the manufacture of timber into lumber the season of greatest production comes somewhat later than the timber-cutting period, usually reaching its peak in the early part of the summer. Sometimes the peak may not be reached until October, as in 1925 for example, but almost invariably the decline comes in the fall, and the low point is reached by December or January.

Manufacturing in general.—The production of manufacturing as a whole in the United States shows a regular seasonal influence. Each year has two maximum points and two low points; January usually shows an increase over the low December. This increase usually continues through the spring to be followed by a summer lessening of activity. A fall increase is then followed by the usual seasonal declines in November and December. This may be seen from the diagram in Fig. 55.

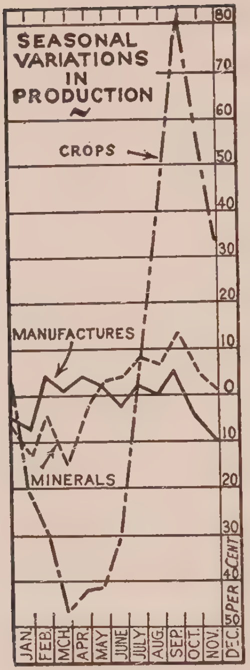
Canning and preserving.—This is another industry employing many casual unskilled workers. Since fruits and vegetables must be canned when they ripen, the industry is necessarily seasonal. In California, the leading fruit and berry canning State, over 55 per cent of the product is canned within eight weeks. Similar conditions exist in this branch of the industry in the eastern States. The United States Census showed that in 1914 the number employed in the country as a whole in the canning and preserving industry varied from 27,917 on January 15 to 185,724 on September 15.

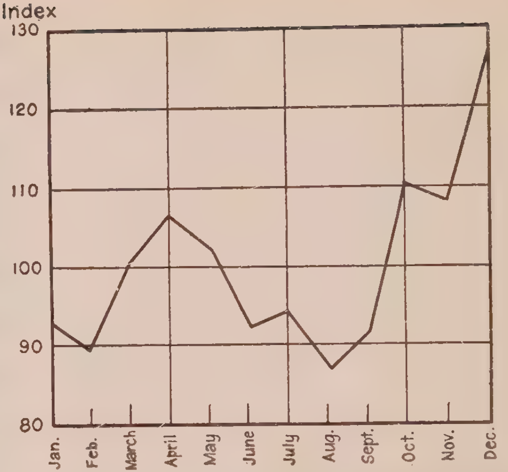
In the western and middle western States the greatest number are employed in canning, in July, August, and September. In the eastern states the peak comes in August, September and October. In the fish canning industry the middle of winter is the season of greatest employment, with an idle period in the spring.

Seasonal industries employing skilled workers.—Industries employing a larger number of skilled workmen are also often subject to marked seasonal variations in activity. Such are the building and allied trades, the clothing industry, millinery and hat manufacture, bituminous coal mining, and so forth.

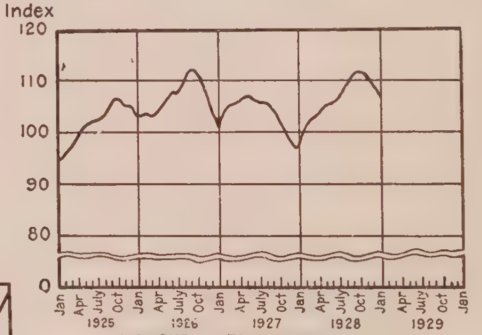
In the last-named industry the seasonal character of the market is one of the leading causes of the irregularity of employment. The low point, reached commonly in the spring and summer, is well shown in the diagram, Fig. 55, upper left.

The *building trades* constitute one of the most important groups of industries decidedly affected by seasonal influences. Custom probably more than climate is largely responsible for the very marked periodicity in the industry. Nevertheless, in spite of efforts on the part of the trade and the government to remedy the situation, its seasonal character persists. The work is largely done after the bidding-on and letting of con-

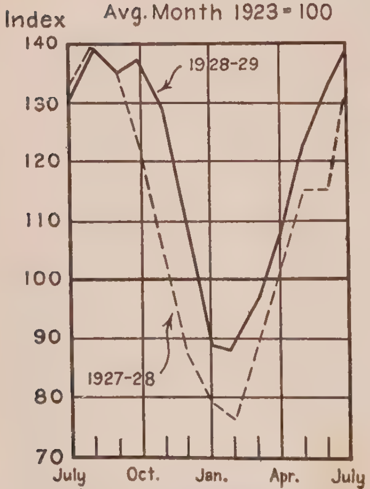




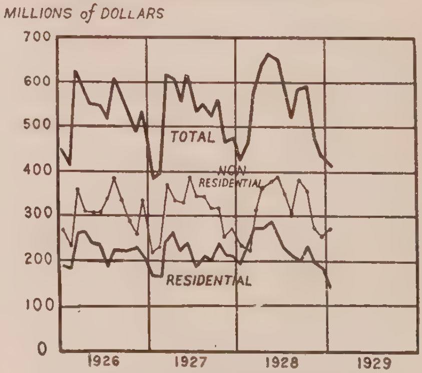
Advertising Linage of Ohio Daily Newspapers–1925
(Average Month = 100)



INDUSTRIAL EMPLOYMENT IN OHIO



Construction Employment in Ohio



Building Contracts Awarded in 37 States

(*Ohio Charts from Reports of Bureau of Business Research, Ohio State University.*)

Fig. 55.—Seasonal Influences on Industry and Advertising.

tracts. The seasonal influence on the letting of the contracts is illustrated in Fig. 55. The seasons when the actual work is done are illustrated in the chart (see Fig. 55) from the July 1929 *Bulletin of the Bureau of Business Research of the Ohio State University,* which shows by index numbers the relative number of wage earners employed in the construction industry in Ohio each month, July 1927 to July 1929. With this industry is very closely connected the portland cement production. (See Fig. 56.)

The *clothing industry* has long been a seasonal industry, and it is still in that class to a considerable extent. It has usually a busy summer season from about June 15th to September 1st, and then a busy winter season from about the first of December to the last of February. The dull seasons are the spring and fall.

In *velvet and felt hat manufacture* there is a rush period during the summer in preparation for the fall trade. After November the season is dull. In women's millinery the flower-factory season comes from January to April or May and the feather-factory season from August to September. Straw-hat factories have a long busy season which extends from late fall to early spring.

The *shoe business* is very seasonal; the retailer makes his purchases in the spring and fall, and, in spite of the manufacturers' efforts to overcome this seasonal ordering by operating 51 weeks in the year, the sales continue to show two maximum and two minimum periods in the year.

Apartment-house managers in large cities recognize distinct *renting seasons,* the fall renting season being particularly pronounced, as may be seen in the increase of newspaper rental ads, and especially in the display advertising, which represents chiefly new and unusually large apartment houses.

Seasons and banking and merchandising.—All bankers in the United States recognize a very regular seasonal fluctuation in the demand for money.[1] Demand for money is inclined to

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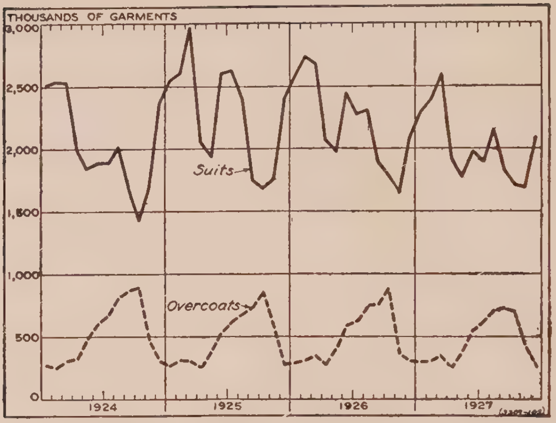
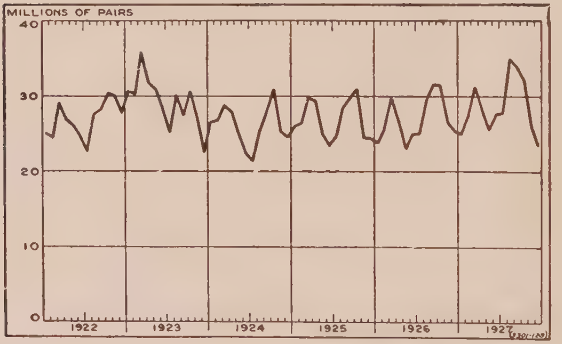
[1] Under the old national banking system the seasonal fluctuations were more pronounced (Fig. 57) than they are now under the new Federal Reserve system, which was established partly to remedy this situation, Fig. 57.

MEN'S AND BOYS' GARMENTS CUT

NOTE.—Figures represent data compiled from reports of 730 identical establishments.

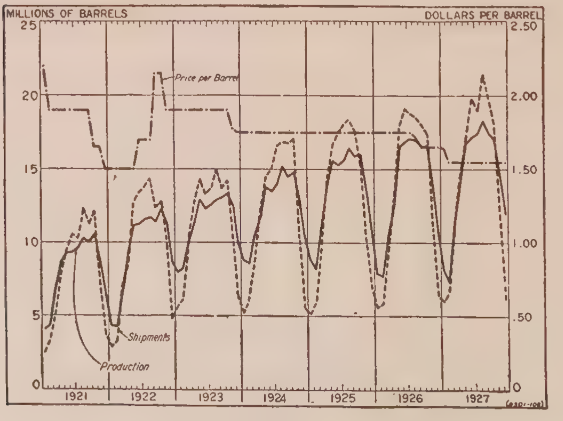


PRODUCTION OF FOOTWEAR (OTHER THAN RUBBER)



PORTLAND CEMENT: PRODUCTION, SHIPMENTS, AND PRICES

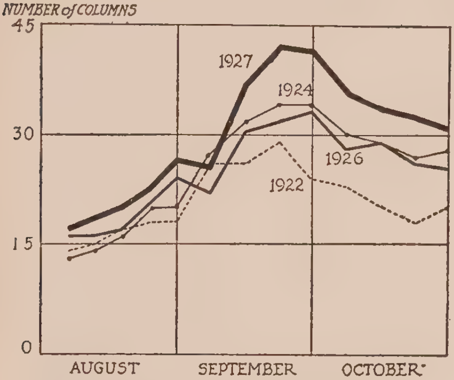
NOTE.—Prices at Lehigh Valley Mills.



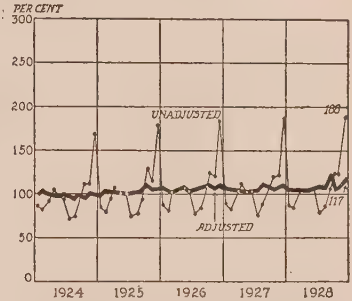
(*From the U. S. Commerce Year Book*)

Fig. 56.—Seasonal Fluctuation in Clothing, Shoe, and Cement Production.

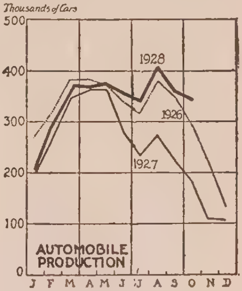
be small in the early part of the year, but it increases in the early spring with the planting of crops and the spring trade. As summer approaches demand again gets smaller, but increases in the fall with harvesting and the autumn trade, and continues large through the holiday period. This may be seen in the graph of commercial paper, or bank credit above.

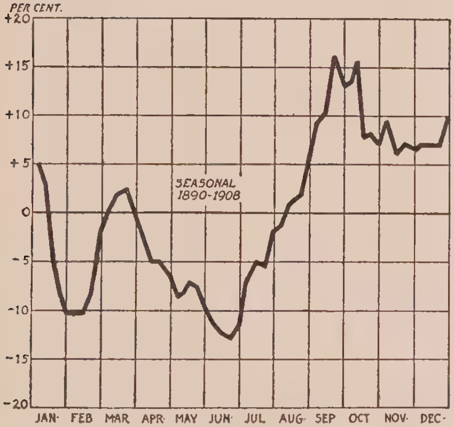


Amount of Advertising of Apartments for Rent in Classified Columns of Sunday Editions of a New York Newspaper during Renting Seasons of 1927 and Previous Years.

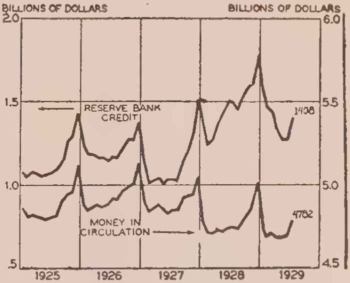


Federal Reserve Board's Index of Department Store Sales, Adjusted for Seasonal Variations and Unadjusted (1923-25 average = 100 per cent).





Typical Seasonal Variation in Commercial Paper Rates before the Federal Reserve System.



Reserve Bank Credit and Money in Circulation (Monthly averages of daily figures; latest figures are averages of first 21 days in July).

Fig. 57.—Seasonal Influences on Banking, Retailing, Advertising, and on Automobile Production.

Marketing of farm crops is heaviest during the five months from August to December, with the peak usually in October. Wholesale trade in certain lines such as groceries and dry goods is more or less seasonal, as is the auto business, while retail trade shows peaks and low points as regular as the seasons themselves, the maximum coming in December. (See graph of retail trade, Fig. 57. The close relation between certain retail selling and advertising is seen in the marked seasonal curve for advertising. (See Fig. 55.)

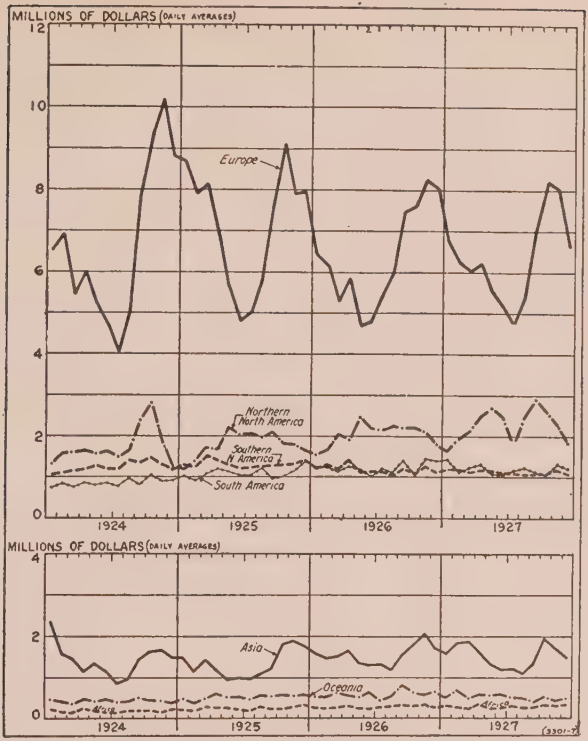
Transportation, depending largely on the basic industries for business, must of course, like them, be seasonal also. This may be seen from the graph of car loadings in Fig. 58.

The export trade.—A glance at Fig. 58 will show that our export trade also is subject to considerable seasonal fluctuation. Some of the minor monthly variations are of course attributable to the different number of days in the calendar month; March, for example, naturally shows annually a heavier trade than the shorter February. So, also, price changes affect the monthly movements as well as changes in quantities. Nevertheless, the curve shows such a similarity of movements at corresponding times each year that one can safely assign part of the cause to the seasons. There is a normal tendency toward a seasonal increase of exports during the fall, owing largely to the exports of crude materials, dominated by large movements of cotton, and exports of crude foodstuffs, dominated largely by wheat. Then usually there is a decline during December and January, followed by a rise in the spring, and by a low point in the summer.

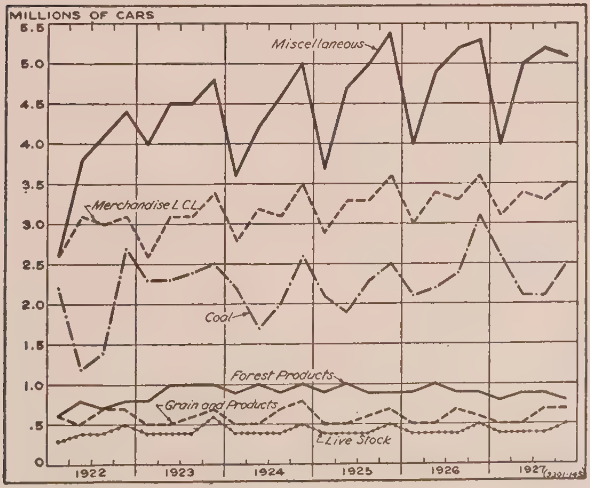
Some commodities exported are naturally much more influenced by seasons than others, crude materials being one such class; and the exports to certain continents are more seasonal than others. The export trade with Europe, our greatest market, is highly seasonal, the peak coming in the fall. Our imports in general, which consist of a very great variety of goods, are not so regularly affected by the seasons as our exports, but imports from North and South America are subject to seasonal influences.

The imports from North America tend to be larger during

DAILY AVERAGE EXPORTS, BY CONTINENTS



CAR LOADINGS OF PRINCIPAL COMMODITY GROUPS, BY QUARTERS (CLASS I ROADS)



(*From the U. S. Commerce Year Book.*)

Fig. 58.—Seasonal Fluctuations in Exports and Car Loadings.

the early months of the year because of large receipts of sugar from Cuba, as that is when the producers of sugar in Cuba are realizing on their crops. From South America the imports are generally lower in the summer on account of reduced arrivals of coffee during that season.

To Central America, a distinctly agricultural region, our exports display a remarkable uniformity year after year in their general increases and decreases according to seasons. Naturally, the Central Americans buy from us mostly during the period of their harvest and crop-selling seasons. Now coffee, their most important single product, is picked from August to December, and the crop is practically all shipped by June; while their sugar season extends approximately from December to May. Bananas are more of an all-through-the-year product. So we find the exports from the United States to Central America reflecting the two distinctly marked purchasing seasons.

Our highest total exports to the region come between the months of October and December. There is a noticeable falling-off in February, March and April, with distinctly higher figures in May and June, and again a decline in the summer months of July and August. Statistics for a period of years show that almost the same variation exists in our exports of chief commodities to Central America, coinciding with total seasonal shipments.

Seasonal exporting of wheat.—There are many factors in the wheat trade. Besides seasonal production and sales, there must be considered, for example, distance, varying yields, and uncertainty in many other factors. Yet it may be said that *seasonal production* is a fundamental factor in the export trade. Taking the world as a whole, wheat is ripening somewhere every month. But on the average, three-fourths of the world crop is harvested in the summer season of June, July and August, when North America and Europe are harvesting, and, during recent years, about two-thirds of the surplus that goes overseas has been exported from the United States and Canada.

Seasonal production is also accompanied by *seasonal sales* by the producers. In nearly all the wheat-producing countries the farmers generally sell soon after threshing begins. From this highly seasonal production and marketing by farmers, however, commercial practice has developed considerable uniformity in the export trade, taking the world as a whole; yet we find relatively heavy shipments from the United States and Canada in the first half of the crop year, and from Argentina and Australia in the last half of the crop year, that is, from January to June, their harvesting season being of course in the time of the year opposite to ours. It is largely because of the variety of world producing seasons and a rather greater regularity of movement from America in response to market demand that a somewhat orderly flow of wheat in international trade is accomplished. About eight-tenths of the world's export goes to western Europe.

Basic industries.—The chart in Fig. 55 illustrates in a general way the influences of seasons on production in the great basic industries, agriculture, mining, and manufacturing. Concentration of production at harvest time naturally causes larger operations late in the year, on account of increasing activity and production in agriculture. Mineral production is, of course, affected not only by natural conditions, but also by consumer demand.

CHAPTER VIII

WEATHER AND MAN

Nature of Weather.

Weather a phase of climate.—Weather has been defined as the atmospheric conditions shown by the meteorological elements at a particular time or during a short specified period. We may refer to the weather of a day, season, or year, but not for a long period of years which would give the average or the aggregate of weather conditions, known as climate. In localities where the atmospheric conditions are frequently changing, the distinction between weather and climate can not be easily made. This circumstance may have given Mark Twain the idea for saying that " New England has no climate; it is all weather," because the extreme variability of New England weather is its distinct characteristic. Then again, in California, where uniformity of weather conditions prevails, it is customary to say that California has all climate and no weather.

Types of weather.—Weather is generally designated according to the predominance of one or more elements of the atmosphere. If rain is the element which attracts our attention, the weather is said to be rainy weather; if temperature, it is hot or cold weather; and if winds, we call it windy weather. These terms are sometimes used in a relative sense in that they emphasize the abnormal atmospheric deviation from the average conditions. For example, " a hot day " usually means hot in relation to the average temperature at a particular time. The conditions that may be spoken of as " hot " at one hour of the day may be referred to as " cool " at another hour. A temperature of 75° F. in the morning would seem hot, but the same temperature at noonday would seem cool. With reference to moisture and wind, these relative measurements are not so commonly used. The presence or absence of precipitation or winds can be expressed in absolute terms. A given amount of rainfall and a certain velocity of the wind would be recognized as a heavy precipitation and a strong wind, respectively, whether they occurred at eight o'clock in the morning or at midday.

Weather influences.—Climate is somewhat fictitious in character, while weather is realistic. No one has seen climate or directly encountered its influences. But nearly every one who has reached the stage of conversation has at some time observed, experienced, praised, and complained about the weather. It constitutes an ever-remindful environmental factor, as is well disclosed by its universal importance as a daily topic for discussion.

Weather, however, is worthy of this recognition because it influences the life of every one. In some cases, the effects of weather are direct and then, again, they may be indirect. The variations of weather influences are as numerous and complex as there are kinds of weather and types of human beings. In Dexter's interesting book on weather influences he says: " Who has not, in some part of his life, at least, experienced the depressing effect of a dull, rainy day on his spirits?—or who has not, on the contrary, felt the exhilaration of dry air and bright glowing sunshine? At times, even in good health, a state of mind comes over us in which casual annoyances seem as if they were to be perpetual. All this may endure for a day, but tomorrow's sun rises bright and cheerful; a wonderful change has come over our spirits,—hope and joy have suddenly taken the place of sorrow."

Weather not only influences the mental state of man, so well characterized by Dexter, but also affects the physiological structure of man, and life in general. Sickness and death are more prevalent during adverse weather conditions, such as abnormal rainfalls, extreme temperatures, variations in temperature and prolonged periods of cloudiness and low atmospheric pressure. Accuracy in work has been found below the standards on warm, humid, cloudy days. In fact, banking institutions have been known to change the nature of the duties of their clerks on oppressive days in order to avoid an excessive degree of errors. The deportment of the pupils in public schools is at its best during cold, calm, and clear weather, and at its worst during that characterized as hot and muggy. Crime is excessive during periods of fair weather. Business conditions are more favorable on pleasant days.

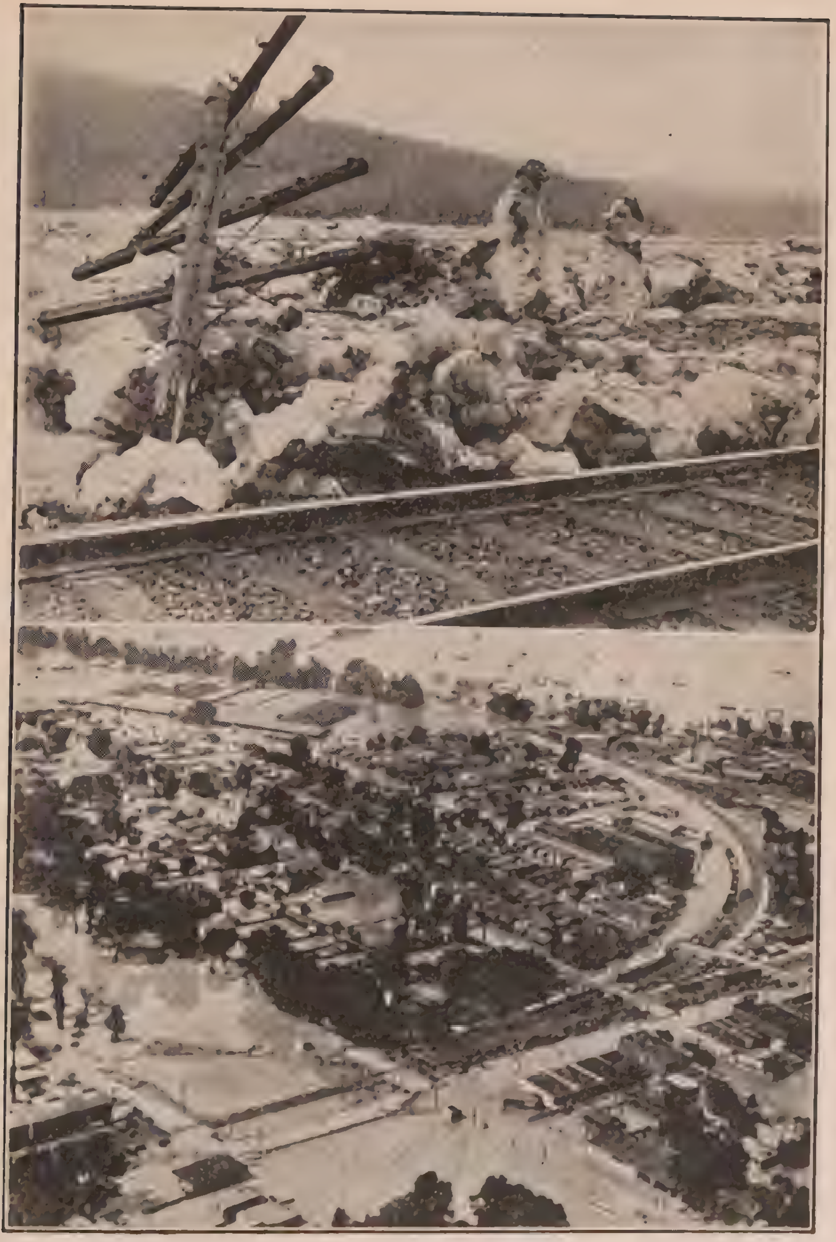
National differences are equally influenced by weather. In the late war we became familiar with military movements depending upon weather. Air raids, gas attacks, the movement of regiments, the transport of troops to Europe, the health of the fighting men, the effectiveness of naval battles and their consequences depended to a great extent upon weather conditions.

Fog interferes with traffic by ocean, land, or air. In London a heavy fog may check traffic for hours, even necessitating a complete standstill. Ocean vessels are frequently delayed in sailing because of fogs. Aviators are constantly reminded of the danger that fogs may introduce.

Snowstorms are equally significant to human activities. A heavy snowfall not only delays or completely checks traffic but adds to the civic expense several hundreds of thousands of dollars. It has been estimated that inadequate snow removal causes a loss to the nation's business in a single winter of $500,000,000. Nearly 70 per cent of the registered motor vehicles in the United States are in the snow belt. The cost of keeping the roads clear from snow in this area is approximately $5,000,000 yearly.

In the spring and summer of 1927 the lower Mississippi basin was devastated by floods, which inundated 20,000 square miles; 250 people were drowned, and 700,000 driven from their homes; while the damage to property was estimated at more than $200,000,000. (See Fig. 59.)

Modification of weather influences.—The natural activities of the atmosphere have been only slightly altered by man. Some attempts have been made to produce rain, but as yet there appears to be no positive scientific information that the efforts have been successful. So Mark Twain's statement is apparently true that "much has been said about the weather, but little has ever been done about it."



Courtesy of W. H. Alexander, U. S. Weather Bureau.

Fig. 59.

Upper.—Ice jam in the Allegheny River, March 1926.
Lower.—Mississippi flood at Leland, Miss., 1927.

While weather conditions are controlled by the laws of nature, the effects or influences of weather have been greatly modified by man. Clothing and shelter are human necessities to modify the effects of weather as well as other environmental factors. Trees are planted to provide shade and protection from the hot sun and violent winds. Water is conveyed over the surface and from below the surface of the earth to regions deficient in moisture; as a result, thousands of acres of land have been made productive. Smoke from smudge stoves is produced to modify the temperature of the air in orchards in order to prevent the freezing of the buds or fruit. Mill, in his book, "The Realm of Nature," summarizes the influences of weather in an effective style: "Much of man's power is evasive. It consists in devising methods of utilizing natural phenomena for the purpose of escaping uncomfortable consequences. Thus, the invention of the umbrella and the sun-helmet give a certain amount of independence of the weather; still more, the methods of heating, cooling, and lighting houses. Lightning conductors reduce the risk to which life and property are exposed in a thunder storm; knowledge of the laws of cyclonic-motion often enables sailors to escape the fury of a storm. . . . Hence, the natural powers are not overcome by man; they are merely utilized."

Weather bureaus.—Since man cannot successfully control the activities of the atmosphere, but rather can only modify and utilize them, it seems apparent that the more he knows about the past, present, and future weather conditions, the more successful is his adjustment. The first record of organized meteorological observations dates back to 1654 when the Duke of Tuscany distributed meteorological instruments and secured the coöperation of several observers in Italy and adjacent countries. This effort was followed during the next century by similar ones in France, England, and Germany.

The United States Weather Bureau was organized in 1870 and placed under the supervision of the War Department. Later, in 1891, it was transferred to the Department of Agriculture.

Weather observations, whether made for the purpose of forecasting, for the collection of climatic data, or for discovering of laws governing atmospheric phenomena, require the coöperation of a large army of collaborators scattered over an extensive area. In the United States, there are about 6000 meteorological stations at which over two and one-half million observations are made every year, mostly by volunteers who receive no compensation for this service. It is estimated that there are 31,000 meteorological stations throughout the world.

The United States Weather Bureau maintains over 200 official observation stations in the United States, Canada, Alaska, and the West Indies. Each station is equipped with mercurial barometers, thermometers, wind vanes, rain and snow gales, anemometers, sunshine recorders, barographs, thermographs, and so on, that record weather conditions and changes.

Daily weather map.—Every day, shortly before 8:00 A. M. and 8:00 P. M., 75° meridian time, the observers at the United States official stations record the atmospheric conditions. The degree of cloudiness is observed; the barometer is read and corrected to sea level; the direction and the velocity of the wind are noted; the rainfall or snow is measured; the moisture content of the air is determined. This information is condensed into a cipher message and telegraphed to one of the collecting centers, either Chicago or New York. Then, at about 8:15 A. M. and 8:15 P. M., the collecting centers send out the weather conditions which they have compiled from all the stations.

Owing to the cost of sending the weather data, the stations do not always receive the information of all the 200 official stations, but select those station reports that will give a wide distribution and representation of the atmospheric conditions in the United States. The Columbus, Ohio, station receives the weather data from about 140 stations twice a day. The central station, Washington, D. C., receives the full report from all the stations.

The weather conditions are plotted on large maps, and finally transferred to one single map which represents the daily weather map. The major stations in each State, such as

Columbus, Cincinnati, and Cleveland print one daily weather map for public distribution, which generally represents the atmospheric condition for 8:00 A. M. 75° meridian time.

Interpretation of weather map.—The weather map tells what the atmospheric conditions are for a given time. It also enables us to say with a considerable degree of accuracy what the weather has been for a day or two in the past, and what it will be for a day or two in the future. Let us consider, first, the method of reading the present weather conditions. The temperature is shown by isotherms—lines passing through places of equal temperature. The isotherms are recorded as dotted lines and drawn at 10° F. intervals. The highest temperature for the past 24 hours, and the lowest for the last 12 hours, for some of the stations is shown in table form at the bottom of the map.

The atmospheric or barometric pressure is represented by lines of equal pressure, known as isobars. The pressure has been reduced to sea level and is expressed in terms of inches. A pressure of 15 pounds per square inch at sea level is recorded as 30 (inches). Obviously an isobar marked "29" indicates a pressure of less than 15 pounds per square inch (standard conditions).

The direction of the wind is shown by arrows, flying with the wind. (Remember that a weather vane points into the wind.) The velocity of the wind is not shown on the map. If it is greater than ten miles an hour it is recorded in the table accompanying the map.

Symbols are placed at the ends of the arrows to indicate the state of weather. Precipitation is shown by symbols in circles—"R" for raining and "S" for snowing. Likewise, cloudiness is shown by means of circles, a black circle indicating a cloudy sky (more than 70 per cent overcast), and a half open circle, partly cloudy (between 30 and 70 per cent overcast), and an open circle a clear sky (less than 30 per cent overcast). Shadowed areas show precipitation of 0.01 inch or more during the last 24 hours. The exact amount for each station is recorded in the table below the map.

In places the word "low" and "high" may appear.

These words mark the approximate centers of the atmospheric pressure areas. Their importance warrants a considerable amount of attention if the future weather conditions are studied, as signified by the weather forecasts or predictions.

Weather forecasting.—In this discussion of weather forecasting we shall confine ourselves to the consideration of the middle latitudes of the Northern Hemisphere, and particularly to the United States. Only the general principles are considered, as a detailed analysis of weather forecasting rightly belongs in the field of meteorology, and not in geography.

Since "lows" (cyclones) and "highs" (anticyclones) constitute the centers of atmospheric activities in the United States, it must follow that a review of their characteristics is basic in the study of forecasting.

"Low" or cyclone.—"Lows" are recognized as storm bodies. Cloudiness, rain, and other forms of precipitation, and general unsettled weather conditions accompany "lows" or cyclones. Reasons for such conditions can be better understood if a brief analysis is made of the structure and movements of cyclones.

A cyclone represents a barometric pressure area in which the pressure decreases towards its center. The pressure is shown by isobars. In the ideal cyclone the isobars are concentric circles, the innermost one of these having the lowest pressure, the outer ones having successively increasing pressure; but the isobaric lines seldom present these regular features, and in nearly every case they are elongated. The range in pressure from the center to the outer margin is small. Only seldom does there appear in the United States a pressure below 28.9 inches or one above 30.7 inches. A wide range in pressure is indicative of a tornado and not a cyclone or "low."

The extent of a cyclone is often a phenomenon in itself. There are wide variations from cyclone to cyclone, but the average extent has been calculated to be some three hundred thousand square miles. This is an area about equal to the combined areas of Kansas, Nebraska, Iowa, Missouri, and a third of Illinois. Some are much smaller, being about the size of a county, or much larger, extending from the Rocky Mountains to the Atlantic Ocean, and from Canada to the Gulf of Mexico.

Since winds blow from high pressure to low pressure, it must follow that in a cyclone the air moves toward the center. It not only moves toward the center but somewhat downward toward the center, moving according to the isobaric gradient or slope between the isobars, much as water flows downhill.

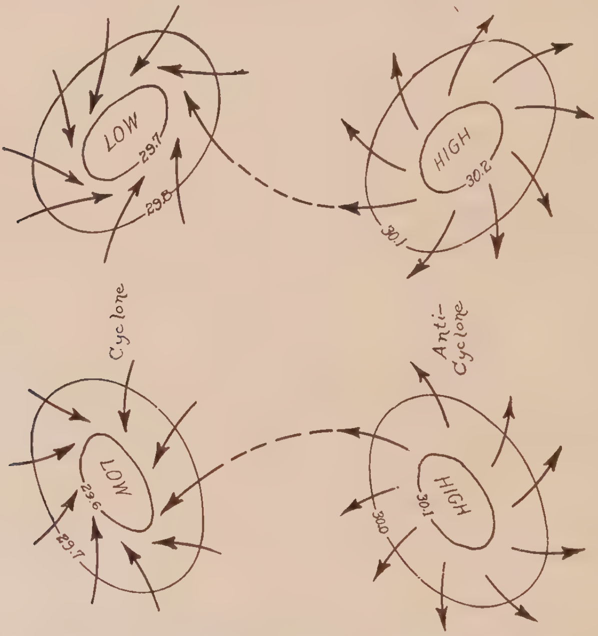


Fig. 60.—Diagram to illustrate isobars, pressure, and wind movements about cyclones and anti-cyclones. Note that the winds do not blow across the isobars at right angles, but are deflected to the right in the Northern Hemisphere and to the left in the Southern Hemisphere. (*Note*: Upper Low and High in Northern Hemisphere and lower Low and High in Southern Hemisphere.)

The air rises in the central area in a whirling manner, which is from right to left—to a person placed in the center of it—or in a direction contrary to that of the movement of the hands of a clock. This counter-clockwise deflection has been discussed as due to the rotation of the earth. (See Fig. 60.)

The wind velocity increases from the outer edge toward the center of a cyclone, but the maximum velocity is reached at some distance from the center—several hundred miles in most cases; and then the velocity decreases again, sometimes with great suddenness. Directly at the center there is usually a calm—in other words, very little horizontal motion of the air. The velocity at the place of maximum wind depends upon the intensity of the cyclone and the steepness of the isobaric slope. Also, northerly winds, generally, move faster than southerly winds.

Since warm air has a greater water-holding capacity than cold air, it follows that the southerly winds in most cases carry more moisture than the northerly winds because, usually, southerly winds are warmer than northerly winds. Where the wind blows from over a water surface, these conditions may be completely opposite. Thus, rain generally occurs on the east or southern side of a cyclone. As these southerly winds, heavily moisture-laden, rise, they are cooled, and precipitation takes place. It is also true that rains occur most frequently on the side of the cyclone which is nearest the supply of moisture, whence this last is carried into the region of the cyclone by the winds blowing in towards the center of the cyclone.

Tornadoes and hurricanes.—It should be noted that the words " cyclone " and " tornado " are not synonymous. A tornado has the general structure of a cyclone or " low," but the atmospheric pressure in the center of the tornado is usually much lower than in the center of a cyclone. Not only is the pressure at the center of a tornado low, but the area of the low pressure is very small. The result is that the isobaric gradient or pressure slope between isobars is very high, and the wind blows in a spiral direction at a great velocity. In very strong tornadoes the pressure at the center may be very near a fourth of that at its margin or surroundings. This is why tornadoes are the most destructive of all windstorms. Tornadoes are associated in most cases with hot days and with the warmest part of the day. They seem to occur most frequently in the hot days of spring or early summer.

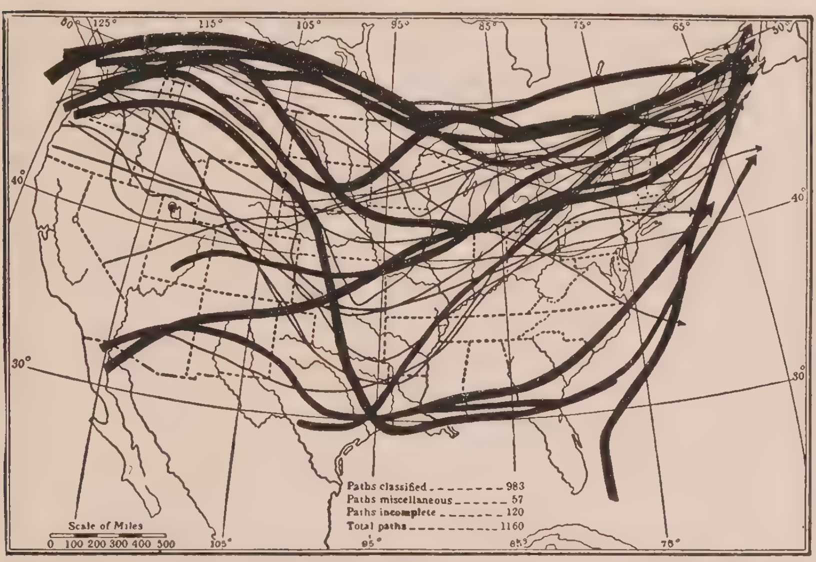
The cyclonic disturbances in the tropical region are known as tropical cyclones. The violent storms are called hurricanes in the Atlantic and typhoons in the Pacific. They resemble tornadoes, except that they are larger and less violent. The Atlantic hurricanes usually start in the region of the West Indies and move northward to the coast of the southern Atlantic States, curving eastward under the influence of the earth's rotation. In some cases they move toward the Gulf States, reaching as far as the Great Lakes. The typhoons seem to have their birth over the western Pacific and Indian Oceans, moving outward in various directions.

These storms, usually, start on water rather than on land. The humid air over the sea provides water vapor, which, on condensing, liberates heat that warms the air, thus causing more rapid rising of the air. These violent storms and the water waves which follow cause great destruction.

Characteristics of " high " or anticyclone.—" Highs " are generally indicative of fair weather as contrasted with " lows," which are frequently associated with storms. An anticyclone is considered as the accompaniment of a cyclone because when there is a decrease of pressure in one place (in a " low ") there must be a corresponding increase in another place (in a " high "). In an anticyclone the air pressure is greater at the center, and decreases from the center in all directions in a somewhat irregular manner. The pressure in anticyclones frequently reaches 30.6 inches, and in some cases it exceeds 31 inches, which is much greater than the maximum pressure in a cyclone. The isobars are also more irregular in an anticyclone than in a cyclone and are usually elongated or elliptical in form, with the major axis usually extending in a relative east-west direction. The size of an anticyclone is generally greater than that of a cyclone. The direction of wind in an anticyclone is outwards, downwards, and in a clockwise motion. As a usual thing the wind velocities are much smaller than those in cyclones.

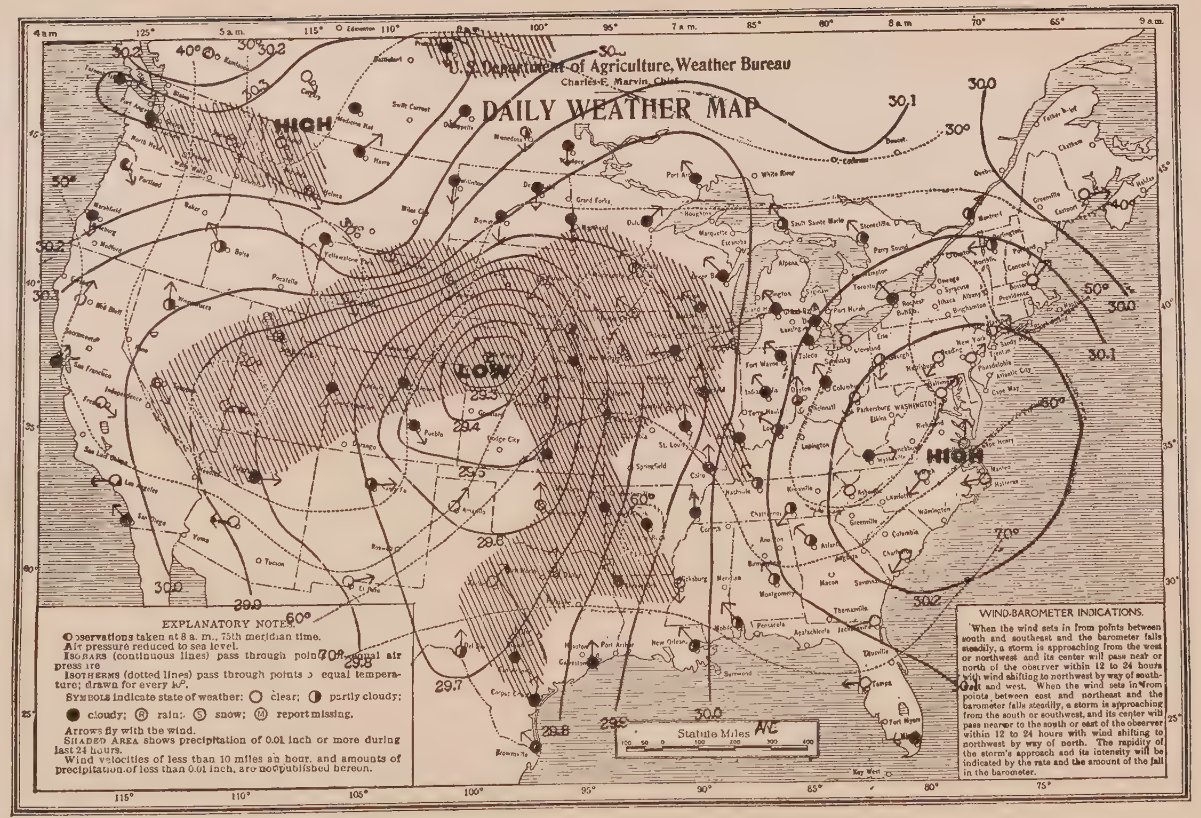
In an anticyclone, the descending air is compressed and becomes denser, and the temperature is raised, by which means the relative humidity is decreased, or the capacity for the air to hold moisture is increased. As a result, dry, cool air, few clouds and only slight precipitation follow. Hence, an anticyclone is generally indicative of clear weather and gentle winds. Under its advance the temperature falls, dropping in extreme cases as much as 30° F. below normal. After its departure the temperature gradually rises.

Paths of "lows" and "highs."—Cyclones and anticyclones are continuously moving across the United States in the direction of the prevailing westerlies, although there are many exceptions. They seem to develop, primarily, in the Far West, somewhere along the line of the Rocky Mountains. About two-thirds of the "lows" make their appearance in the northwest, particularly in the Canadian province of Alberta and on the northern Pacific coast. Approximately, the remaining one-third of "lows" develop on the Pacific coast, south of 40° N. L. in Texas, on the Gulf coast, on the Atlantic coast, south of 40° N. L., and in the region of the mouth of the Ohio River. The "lows" of the northwest progress across the United States along the northern circuit, and the "lows" of the southwest move along the southern circuit. Both circuits tend toward the northeast.


125°
115°
105°
95°
85°
75°
65°
50°
40°
40°
30°
30°
Paths classified 983
Paths miscellaneous 57
Paths incomplete 120
Total paths 1160
Scale of Miles
0 100 200 300 400 500
105°
95°
85°
75°

After Van Cleef

Fig. 61.—Paths followed by a number of low pressure areas, cyclonic storms, or "lows," across the United States. The width of the lines indicates the comparative frequency of storms following each track.



EXPLANATORY NOTES.

Observations taken at 8 a. m., 75th meridian time.

Air pressure reduced to sea level.

ISOBARS (continuous lines) pass through points of equal air pressure.

ISOTHERMS (dotted lines) pass through points of equal temperature; drawn for every 10°.

SYMBOLS indicate state of weather: ○ clear; ◑ partly cloudy; ● cloudy; Ⓡ rain; Ⓢ snow; Ⓜ report missing.

Arrows fly with the wind.

SHADED AREA shows precipitation of 0.01 inch or more during last 24 hours.

Wind velocities of less than 10 miles an hour, and amounts of precipitation of less than 0.01 inch, are not published hereon.

WIND-BAROMETER INDICATIONS.

When the wind sets in from points between south and southeast and the barometer falls steadily, a storm is approaching from the west or northwest and its center will pass near or north of the observer within 12 to 24 hours with wind shifting to northwest by way of southwest and west. When the wind sets in from points between east and northeast and the barometer falls steadily, a storm is approaching from the south or southwest, and its center will pass near or to the south or east of the observer within 12 to 24 hours with wind shifting to northwest by way of north. The rapidity of the storm's approach and its intensity will be indicated by the rate and the amount of the fall in the barometer.

Fig. 62.

COLUMBUS, O., WEDNESDAY, APRIL 24, 1929

WEATHER FORECASTS

FOR THE 24 HOURS BEGINNING 8 P.M. TO-DAY

For Columbus and Vicinity: Showers and thunderstorms to-night and Thursday, somewhat warmer to-night, cooler Thursday afternoon or night.

FOR OHIO: Occasional showers and thunderstorms to-night and Thursday; somewhat warmer to-night, cooler Thursday in west and central portions.

FOR INDIANA: Showers and thunderstorms to-night and Thursday; slightly warmer to-night in east portion, increasing southeast to south winds, possibly strong.

FOR WESTERN PENNSYLVANIA: Increasing cloudiness and warmer to-night, followed by showers and thunderstorms beginning late to-night or Thursday.

FOR WEST VIRGINIA: Increasing cloudiness and warmer to-night, followed by showers and thunderstorms beginning late to-night or Thursday.

FLYING WEATHER FORECAST FOR ZONE 5.

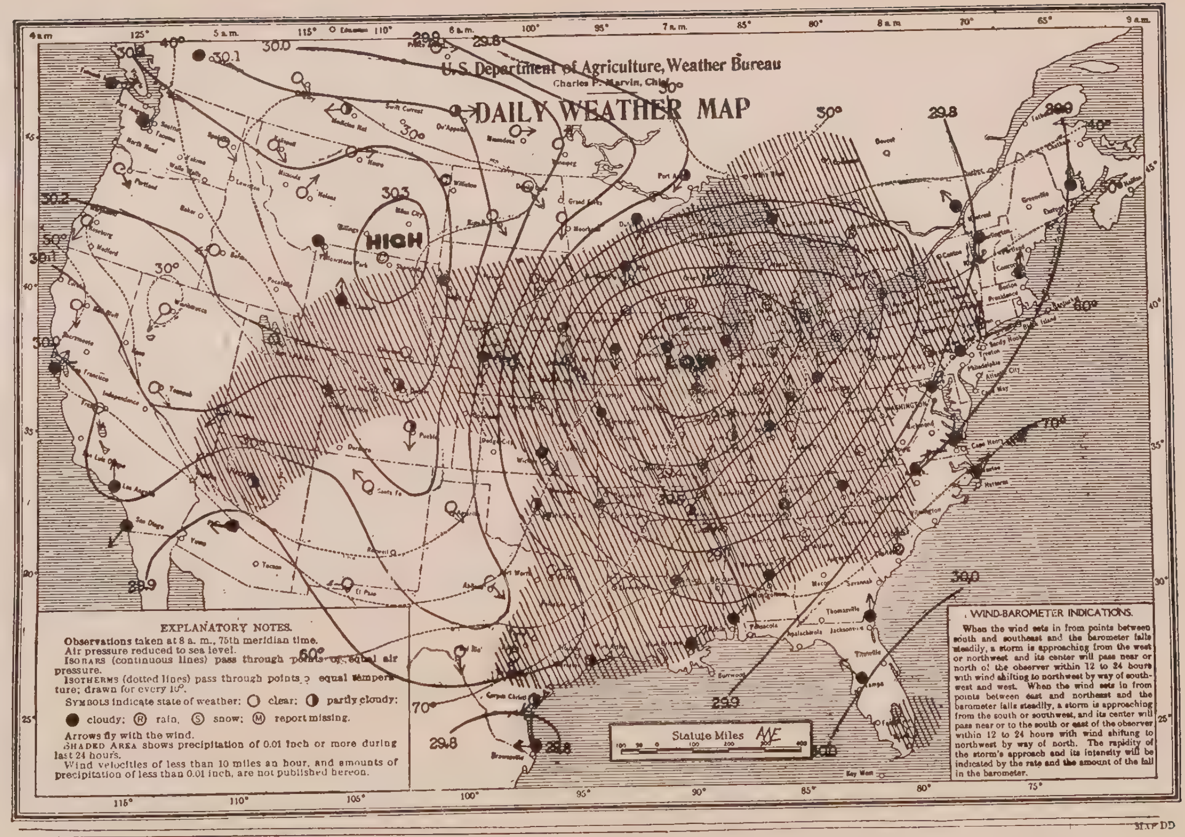
(FROM NOON UNTIL DARKNESS TO-DAY.)

Partly overcast to overcast sky this afternoon with risk of showers and thunderstorms over extreme western portion; moderate southerly winds surface and moderate to fresh southwest aloft.

GENERAL WEATHER CONDITIONS

The eastern "high" has diminished somewhat in extent and is now centered over the middle Atlantic Coast, Norfolk and Hatteras, 30.26 inches; under its influence the weather continues fair and in places a little cool in the Atlantic States. The western "low" has deepened somewhat and has overspread the Plains States, being now centered over Nebraska, North Platte, 29.24 inches; under its influence the weather has become unsettled and showery as far east as the Mississippi River and cloudiness is increasing over the Ohio and Tennessee valleys. This "low" is accompanied by a thunderstorm belt that at present extends from north Texas to Iowa, in which heavy local rains occurred. The eastward advance of this area will be favorable to a further rise in temperature in this vicinity to-night with showers and thunderstorms to-night and Thursday, followed by cooler on Thursday afternoon or night.

WILLIAM H. ALEXANDER.



EXPLANATORY NOTES.

Observations taken at 8 a. m., 75th meridian time.

Air pressure reduced to sea level.

ISOBARS (continuous lines) pass through points of equal air pressure.

ISOTHERMS (dotted lines) pass through points of equal temperature; drawn for every 10°.

SYMBOLS indicate state of weather: ○ clear; ◐ partly cloudy; ● cloudy; Ⓡ rain, Ⓢ snow; Ⓜ report missing.

Arrows fly with the wind.

SHADED AREA shows precipitation of 0.01 inch or more during last 24 hours.

Wind velocities of less than 10 miles an hour, and amounts of precipitation of less than 0.01 inch, are not published hereon.

WIND-BAROMETER INDICATIONS.

When the wind sets in from points between south and southeast and the barometer falls steadily, a storm is approaching from the west or northwest and its center will pass near or north of the observer within 12 to 24 hours with wind shifting to northwest by way of southwest and west. When the wind sets in from points between east and northeast and the barometer falls steadily, a storm is approaching from the south or southwest, and its center will pass near or to the south or east of the observer within 12 to 24 hours with wind shifting to northwest by way of north. The rapidity of the storm's approach and its intensity will be indicated by the rate and the amount of the fall in the barometer.

Fig. 63.

COLUMBUS, O., THURSDAY, APRIL 25, 1929

WEATHER FORECASTS

FOR THE 24 HOURS BEGINNING 8 P.M. TO-DAY

For Columbus and Vicinity: Probably thundershowers this afternoon, to-night rain and cooler, Friday fair and cool. Strong shifting winds and gales.

FOR OHIO: Cloudy with rain to-night and possibly in east portion Friday morning; cooler to-night and in extreme east portion Friday; strong shifting winds and gales.

FOR INDIANA: Generally fair to-night and Friday except probably rain to-night in north portion; cooler to-night; fresh to strong west to northwest winds to-night.

FOR WESTERN PENNSYLVANIA: Rain to-night and Friday; cooler; strong southwest winds shifting to northwest.

FOR WEST VIRGINIA: Cloudy with rain to-night and possibly in north portion Friday; cooler; strong southwest shifting to northwest winds.

FLYING WEATHER FORECAST FOR ZONE 5.

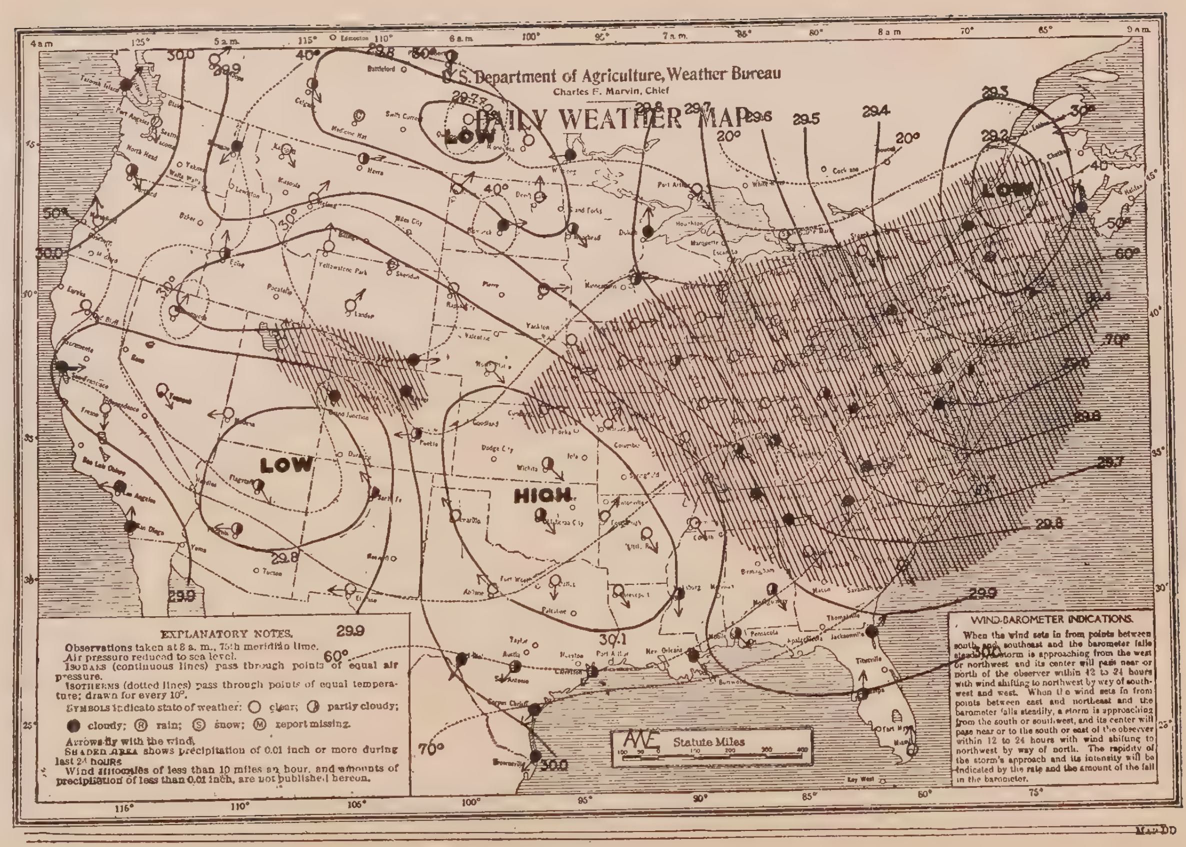
(FROM NOON UNTIL DARKNESS TO-DAY.)

Overcast sky with rain this afternoon except clearing over extreme south portion; strong southwest winds and gales shifting to northwest over lower Ohio Valley at surface and west-southwest gale aloft.

GENERAL WEATHER CONDITIONS

The storm centered yesterday morning over Nebraska is now over central Illinois, Springfield, 29.26 inches. This storm is causing very nearly general rains over the eastern half of the country and a change to warmer in most districts east of the Mississippi River, the rains being heavy over considerable areas but in Ohio mostly light. The depth of this storm makes it favorable to the development of local wind and thunderstorms. This storm is apparently headed for the St. Lawrence Valley and its passage thence will be attended by rain and perhaps thunderstorm in this vicinity this afternoon and to-night. Following it, is an anti-cyclonic area that at present covers the Northwest and is rapidly overspreading the Plains States and the Mississippi Valley attended by clearing, cooler weather. This latter area will reach and overspread the Ohio Valley to-night; hence, in this vicinity, clearing and cooler weather may be expected late to-night and fair, cool weather on Friday.

WILLIAM H. ALEXANDER.



EXPLANATORY NOTES.

Observations taken at 8 a. m., 75th meridian time.
Air pressure reduced to sea level.
ISOBARS (continuous lines) pass through points of equal air pressure.
ISOTHERMS (dotted lines) pass through points of equal temperature; drawn for every 10°.
SYMBOLS indicate state of weather: ○ clear; ◐ partly cloudy; ● cloudy; Ⓡ rain; Ⓢ snow; Ⓜ report missing.
Arrows fly with the wind.
SHADED AREA shows precipitation of 0.01 inch or more during last 24 hours.
Wind velocities of less than 10 miles an hour, and amounts of precipitation of less than 0.01 inch, are not published hereon.

WIND-BAROMETER INDICATIONS.

When the wind sets in from points between south and southeast and the barometer falls steadily, a storm is approaching from the west or northwest and its center will pass near or north of the observer within 12 to 24 hours with wind shifting to northwest by way of southwest and west. When the wind sets in from points between east and northeast and the barometer falls steadily, a storm is approaching from the south or southwest, and its center will pass near or to the south or east of the observer within 12 to 24 hours with wind shifting to northwest by way of north. The rapidity of the storm's approach and its intensity will be indicated by the rate and the amount of the fall in the barometer.

Fig. 64.

COLUMBUS, O., FRIDAY, APRIL 26, 1929

WEATHER FORECASTS

FOR THE 24 HOURS BEGINNING 8 P.M. TO-DAY

For Columbus and Vicinity: Fair to-night and Saturday; somewhat warmer Saturday.
FOR OHIO: Fair to-night and probably Saturday; somewhat warmer Saturday.
FOR INDIANA: Generally fair to-night and Saturday; slightly warmer Saturday, possibly light frost to-night in north and central portions.
FOR WESTERN PENNSYLVANIA: Fair, possibly light frost in exposed places to-night; Saturday fair and somewhat warmer.
FOR WEST VIRGINIA: Fair and slightly cooler, possibly light frost in exposed places to-night; Saturday fair and somewhat warmer.

FLYING WEATHER FORECAST FOR ZONE 5.

(FROM NOON UNTIL DARKNESS TO-DAY.)

Clear to partly overcast sky this afternoon with risk of light rain over extreme east portion; moderate to fresh northwest winds surface and strong northwest aloft.

GENERAL WEATHER CONDITIONS

The storm that was centered over Illinois on Thursday morning has moved northeast to the St. Lawrence Valley. It has caused a general rain from Iowa to the Atlantic coast with thunderstorms in the Ohio Valley, lower Lake Region and along the coast. Light hail occurred in several localities in Ohio Thursday afternoon. The northwestern "high" has spread down over the lower Plains States and Mississippi Valley and fair, cooler weather prevails this morning throughout most of the Mississippi basin. Frost was reported this morning from Colorado and Wyoming eastward to Iowa. With the further eastward advance of the western "high" fair weather may be expected in this vicinity during the next 36 hours.

J. M. KIRK
Temporarily in Charge.

Anticyclones, like the cyclones, make their appearance generally in the Far West. Their paths across the United States are also toward the northeast, with a proportionally greater number of them following the northern circuit. In general it can be said that cyclones and anticyclones follow the same courses. The rate of movement of anticyclones and cyclones is decidedly different. Anticyclones travel with less speed and with less uniformity. The average rate of progress for an anticyclone in winter is about 27 miles an hour to the cyclone's 32 miles, and in summer 21 miles an hour to the cyclone's 26. It takes the average anticyclone a day longer than a cyclone to pass a given place.

Summary of weather forecasting.—While it is impossible to establish all of the principles of forecasting on the basis of the preceding brief discussion of the atmospheric pressure areas, it may be advisable to suggest a few. Forecasting involves: first, a knowledge of the characteristics and behavior of "lows" and "highs"; second, information concerning the place of development, path of progression, and rate of movement of the "lows" and "highs" (which is essential); third, training in the atmospheric and surface characteristics which may disturb the normality of the "lows" and "highs"; and fourth, experience in forecasting, which is an indispensable factor in making correct decisions.

About 20 *per cent of the predictions fail,* because cyclones and anticyclones may (1) depart from their course, (2) travel faster or slower than their normal or calculated speed, (3) change their character in becoming weaker or stronger, and (4) apparently violate all laws of the atmosphere, becoming so-called freak pressure areas. Then, again there may be a lack of meteorological data to take care of special or unusual cases. In all respects, however, weather forecasting by short periods can be considered successful and provides a valuable source of information.

Importance of weather forecasting.[1]—The extent to which the work of the Weather Bureau, in the collection and publication of data and the issue of weather forecasts and warnings, affects the daily life of the people and becomes a factor in their various vocations and business enterprises, already very great, is increasing yearly.

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[1] Taken from United States Weather Bureau publications to show not only the importance of weather forecasting but also the effect of weather on human activities.

Storm warnings are displayed at more than 400 points along the Atlantic, Pacific, and Gulf coasts, and along the shores of the Great Lakes, including every port and harbor of any considerable importance; and so nearly perfect has this service become that for years few storms of marked danger to maritime interests have occurred for which ample warnings have not been issued from 12 to 24 hours in advance. The reports from the West Indies are especially valuable in this connection, as they enable the bureau to forecast with great accuracy the approach of those destructive hurricanes which, during the period from June to November, are likely to sweep the Gulf and Atlantic coasts. The sailings of the immense number of vessels engaged in our ocean and lake traffic are largely determined by these warnings, and those displayed for a single hurricane are known to have detained in port on our Atlantic coast vessels valued with cargoes at over $30,000,000.

The warnings of those sudden and destructive temperature changes known as " cold waves " are of marked importance. These warnings, which are issued from 24 to 36 hours in advance, are disseminated throughout the threatened regions by means of flags displayed at regular Weather Bureau and subdisplay-stations, by telegraph, telephone, radiograph, radiophone, and mail service to all places receiving the daily forecasts, and to a large number of special addresses in addition. The warnings issued for a single cold wave of exceptional severity and extent resulted, as estimated by beneficiaries, in saving over $3,500,000 through the protection of property from injury or destruction.

Cold wave and frost warnings of value to fruit industry.— The warnings of frosts and freezing weather are also of immense value, particularly to the fruit, sugar, tobacco, cranberry, and market-gardening interests. The early truck-raising industry, so extensively carried on in the regions bordering on the Gulf and south Atlantic coasts and in Florida, and which has increased so greatly in recent years, is largely dependent for its success on the coöperation of the Weather Bureau in this particular, and the growers of oranges and other fruits in Florida and California have received great benefit or escaped losses aggregating many millions of dollars. The value of the orange bloom, vegetables, and strawberries protected and saved on a single night in a limited district in Florida, through warnings of freezing weather sent out by the bureau, was reported at over $100,000. In the citrus-fruit districts of California it is reported that fruit to the value of $14,000,000 was saved by taking advantage of warnings issued by the bureau during one cold wave.

The deciduous-fruit growers of Washington, Oregon, Idaho, Utah, Colorado, and the other sections rely upon the warnings of the bureau to guide them in smudging and heating their orchards on the occurrence of frost or freezing weather during the blossoming period.

Temperature surveys are made in fruit districts in several parts of the country, by which the temperature relations between various sections, differing in susceptibility to frost, are determined, to supply information as to the suitability for fruit growing in relation to the frost hazard. Numerous substations are maintained in some of the principal fruit areas, especially in the more western States, during the danger period of the year, and trained meteorologists are assigned to assist the fruit growers in protecting their orchards from frost. Considerable experimental work is also done to determine the most efficient and economic methods of protection, for the information of horticultural interests.

While the value of the bureau's reports and warnings to many interests is so obvious as to need scarcely more than the brief mention already given, there are numerous special applications of the information to individual pursuits and industries that may not be realized by the public. An account of some of these may lead to an increased use of the data in quarters where the possibility of their application has not yet been recognized, and additional details of the manner in which the information is utilized in a number of enterprises will doubtless be found to be of interest to the general reader.

Other industries benefited.—The railway and transportation companies make continuous use of the forecasts in all of their shipments. Perishable products are protected against temperature extremes by icing or heating, as conditions may require. Shipments of perishable goods are often accelerated when it is found possible to carry them to their destination in advance of the expected unfavorable temperature conditions. When this cannot be accomplished, goods en route are run into roundhouses for protection. Also, an advance notice of a cold wave will often hold up a contemplated shipment until after the freeze has passed, and if the cold is protracted the companies will refuse to receive consignments of goods likely to be injured by low temperatures. These precautions apply in some instances to prospective temperature changes within comparatively narrow limits. Bananas, for example, require very careful handling and must be kept at a temperature of 58° to 65° F. during shipment, as a temperature below 55° chills the fruit sufficiently to cause a deterioration in quality, while a temperature above 65° inside the car will produce overripening. As bananas generate heat rapidly after being placed in the car, the problem of maintaining the requisite temperature becomes a delicate one, involving careful ventilation and a study of actual and expected temperature conditions along the entire line of transit.

Similar precautions, based on the information of the daily forecasts and supplemented by a study of the daily weather map, apply to shipments of vegetables, fruits, eggs, and other products liable to damage from extremes of temperature. On the other hand, most meats are shipped in cold weather, although use of refrigerator cars prevents loss, and the shipment of live hogs and cattle by freight is avoided, if possible, when a hot wave is expected. High temperatures are also harmful to certain other shipments, especially of fish and oysters, so that the question of the proper amount of ice to be used is intimately connected with the forecasts issued by the bureau. The daily forecasts and the reports of general weather conditions likewise assist in determining the points to which many shipments of perishable articles are directed, in order to meet the irregular demands that are frequently dependent upon the kind of weather that prevails in a given section. The movement of eggs kept in storage, for instance, is largely regulated by temperature changes, the announcement of a cold wave being usually followed by brisker shipments from western supply districts to the eastern markets, in anticipation of a rise in prices.

The uses made of temperature forecasts in the cities are more varied than is generally supposed. With notice of an approaching cold wave greenhouses are closed and boilers fired. Preparations are at once made by heating and lighting plants, whether gas, electric, steam, or hot-water, to meet the increased demands that will follow. Fire plugs, exposed mains, and general plumbing are protected. Large stockyards drain their mains. Gasoline engines are drained, and automobile water-cooling systems are protected by the use of antifreeze solutions. Work in concrete is stopped. Street railway companies arrange for more heat in their cars. Natural-gas companies turn a larger amount of gas into their lines to provide for increased consumption. Merchants curtail advertisements or direct attention largely to cold-weather articles. Oyster dealers lay in a large stock. Coal dealers supply partial orders to all customers needing fuel, instead of full orders to a few, and thus serve all of their patrons. Ice factories reduce their output. The dredging of sand and gravel ceases, and iron ore piled up for shipment is placed in the holds of vessels, to prevent the wet masses from freezing solid. Charity organizations prepare to meet increased demands for food and fuel, and thus minimize suffering among the poor.

Value of weather reports to farmers.—In the agricultural districts the frost and cold-wave warnings are invaluable to the trucker and fruit grower, especially in the spring, when the tender vegetables are protected by covering with paper, cloth, or voile, and fruit is safeguarded by smudging, irrigation, or other methods designed to maintain the temperature above the danger point. In the fall these warnings are utilized in the cranberry regions by flooding the bogs until after the cold weather has passed or danger of frost is over. Many crops, such as beans and grapes, are saved by being picked in advance of the freeze, while tobacco and unmatured corn are cut at once upon advance notice of damaging cold weather. Potato-crop digging is suspended and the dug potatoes removed from the field, and sugar cane is cut and windrowed upon receipt of such warnings, immense savings having resulted in the sugar districts of Louisiana as a result of such action. The expected duration and severity of freezes govern operations in the ice harvest. If the cold is to be prolonged, the icemen await the desired thickness, but otherwise the cutting will be hastened in order to secure the best possible returns under the circumstances. Forecasts in spring are helpful in the maple-sugar industry, as the collection and boiling of the sap are more or less dependent upon the coming conditions. The temperature forecasts are also largely utilized by farmers in the killing of hogs, by sheep men at lambing and shearing time, and by stockmen in general at critical seasons of the year.

Fruit growers are often given valuable service through the supplying of advance warnings of impending cold waves, which enables them to make adequate preparation for fighting frost. Acting on the advice of fruit-front specialists that an unusually severe frost would likely be experienced in a day or so, which would probably require additional fuel supply, the growers in southern California on Christmas Eve and Christmas Day, 1924, to meet the impending emergency, rushed into the orange groves 300 carloads and 175 truck loads of oil, in addition to the full capacity of their regular freight supply. It later proved that if this additional fuel had not been provided, vast quantities of fruit would have been lost. In the Pacific States alone there are some 4,000,000 orchard heaters in use, in the operation of which the growers depend largely on information and warnings given by the Weather Bureau.

In the raisin-growing districts of California rain forecasts are of great value. The raisin crop while drying is extremely susceptible to injury from rain, and the warnings enable the producers to protect the fruit by stacking and covering the trays. The accuracy of the rain forecasts for this region and the system for their distribution have been so complete that practically no loss from this cause has occurred for years. Rain forecasts are also utilized in the large fruit-growing districts to enable picking in advance of rains, so that the fruit can be shipped dry. Vegetables dug in dry weather are also shipped in better condition than those upon which rain has fallen after they have been taken from the ground. Broom corn is liable to damage from rain if left in the field. Much saving in alfalfa cutting has resulted from consulting the forecasts, since the alfalfa hay can be baled in the field if dry, but if baled wet will spoil. The same benefits derivable from rain forecasts apply to alfalfa cut for seed, since a heavy fall of rain upon the crop, after cutting, ruins its commercial value. Rain forecasts are also of much benefit in fruit districts in connection with spraying operations and in other districts during harvesting. Lime, cement, brick, draintile, and sewer-pipe material all require protection from rain during the process of manufacture, and cement work must be protected from rain for from 24 to 48 hours after the cement is laid.

Various uses of forecasts and warnings.—The rain forecasts are used by contractors in their roofing work. Photographic firms working on a large scale find them helpful in planning for panoramic views. City departments determine the number of teams needed in street sprinkling, railroad companies guard against washouts, and irrigation companies control the output of water according to expected conditions of rainfall. Physicians use the forecasts in advice to patients suffering with inflammations of the throat, nose, or ear, where it is expedient that the sufferer should be kept indoors. They are also used by dentists, many of whom make appointments for bright days and reserve their plate work for days with inclement weather. A knowledge of temperature and moisture conditions in advance is of assistance in blast-furnace operations in determining the quality of the output. Warnings of heavy snows are very valuable to railroads by enabling them to organize their snow-fighting equipment and to reduce, if necessary, the tonnage of their freight and passenger trains. They are also necessary on the great western ranches and plains, where the stock is hurried from the ranges to shelter upon notice of blizzards, northers, or heavy snows. Forecasts of bad weather resulting from low temperatures, heavy rains, heavy snows, or a combination of these, are used in regulating advertising, in arranging for automobile or other outdoor trips, in providing for indoor work on the farms, and in guarding school children from exposure to the elements.

Some special uses of the storm warnings are found in the measures adopted to protect property and crops subject to inundation from high tides or backwater blown up by the winds. In advance of a predicted storm, rice planters flood their crops to prevent the straw from being broken by the winds. Agents of marine insurance companies refrain from insuring cargoes after a storm has been predicted. Fishermen take steps to protect their boats and nets. Lumbermen make their standing booms secure and regulate their log towing. At lake ports vessels load hurriedly if they can get off two to five hours in advance of offshore winds; if snow is also expected, a start of seven to eighteen hours is necessary. Considering the cost of operating a vessel, whether standing or moving, a day saved from idleness in the harbor means an appreciable saving in expense.

Among the miscellaneous uses of the various classes of forecasts are their application to the manufacture of certain articles where slight changes in temperature, moisture, and other weather elements have been found to affect the quality of the product. This is true of certain stages in the manufacturing of bluing, varnish, oils, cement, lime, bricks, paper, photographic supplies, chocolate candies, and some acids. They also serve usefully the plans of public amusement companies, excursion enterprises, awning companies, and those engaged in outdoor painting.

Weather maps and statistics much used by the public.—The daily maps and bulletins, and the general bulletins and reports containing statistical data are utilized in many ways by the public. Grain and cotton brokers are guided largely by the forecasts in their operations, but need the daily report of current weather conditions as well in their business transactions, while in a lesser degree the retailer and the small farmer can also use the same information to advantage. Data of atmospheric pressure are used in tests of boilers, radiators, and automobiles, and in studies of the amount of fuel required to drive engines under varying atmospheric pressures. Statistics of wind force and direction assist in the installation of water-supply systems to be operated by windmills, in determining the origin of fires resulting from flying sparks, the pressure to which large buildings will be subjected under stress of heavy storms, and the surface movement of lake waters in connection with the disposal of city sewage. The humidity records are used by silk and candy manufacturers, in tuberculosis investigations, and in studies of the loss of electric current in high-voltage transmission.

Data regarding rainfall and snowfall are extremely useful in planning irrigation enterprises and selecting reservoir sites, and are studied in connection with the construction of waterworks, bridges, culverts, and sewers. River data are utilized by filtration plants in guiding their methods of chemically purifying water used for drinking purposes, since the conditions of the raw-water supply, as regards bacteria content and turbidity, are greatly affected by the height of the river and the amount of rainfall. They are also necessary in studies of stream flow, dredging operations, the location of wharves, the construction of dams, and in practically every phase of bridge building, levee work, and in general improvement. Weather maps are used by business men generally, by aëro clubs in studies for flights, and by school teachers in class instruction.

The miscellaneous climatological data are used in medical and scientific studies of the relation of weather to diseases and other conditions of health, life, or human pursuits; by railroad companies in the adjustment of claims, and demurrage charges; by homeseekers; by invalids in search of health resorts; by irrigation investigators; by contractors and builders in settling labor accounts; by merchants in studies of the relation of the weather to their daily sales; by gas and electric companies in showing their customers the relation of their monthly bills to the varying hours of daylight at different seasons of the year; as adequate testimony in court proceedings; in dry-farming investigations; in studies of soil culture, practical agriculture, and the life and migration of insect pests; in plans for the development of the arid regions; in the preparation of historical records; by bond and investment companies; in short, in nearly every calling in which the weather plays any part.

Many more uses of the warnings and reports might be cited, but those already given—all of which are taken from personal letters received at the central office of the Weather Bureau or at its field stations—will suffice to show the extent to which they are utilized by the public in the practical affairs of everyday life.

Rivers and flood service.—Human life and large property interests along the rivers of the United States are safeguarded by the issue of flood warnings, the importance of which is emphasized by the disastrous floods during past years.

The river and flood service is organized with its principal headquarters at the central office of the Weather Bureau, Washington, D. C., and subsidiary district centers at advantageous points on the respective rivers along which a service is maintained. About 66 district centers are maintained outside of Washington.

Measurements of precipitation on the headwaters of the streams and observations of the height of water on the gage at upstream points are collected by telegraph or telephone, from about 800 substations and serve as the basis for warnings of floods in the lower reaches of the streams. A second useful purpose is served on navigable streams, namely, that of giving notice of boating stages during the low-water season.

In recent years the operation of the great system of locks and dams on the Ohio River for the benefit of navigation has necessitated a considerable increase in the river and rainfall service of the entire Ohio basin. Reports are received and river forecasts issued early each morning, and instructions for operation of the dams are based upon these. The dams are operated by the Corps of Engineers, United States Army, whose cordial co-operation has greatly facilitated the work of the Weather Bureau.

Flood warnings are indispensable to all river industries, as well as to the operations carried on in the lowlands subject to inundation. Their issue is followed by the removal of cattle from bottom lands and by the saving of such crops as can be cut before the high water reaches the threatened district. Foreknowledge of expected river stages is also of great advantage in determining whether or not it will be advisable to undertake farming operations in the regions subject to overflow. The warnings enable fishermen to remove their fishing gear from the water, so as to avoid damage from driftwood and logs that are brought downstream by the rise, and to devote their energies to gathering this drift for sale.

Along the river streets of many cities the basements of warehouses and other buildings are submerged at high water; accurate river forecasts enable business men to postpone moving their goods to the upper floor until the last moment, and often prevent the needless expense of such a transfer in cases where it is known that the flood crest will be below the point at which their basement stock would be imperiled. The warnings enable dealers to save wood and ties piled along the river banks. High stages of water are frequently utilized by coal barges, enabling the cargo to be run aground at a desirable point at flood height, and then to be unloaded at leisure after the river falls. Navigation companies utilize them in arranging for the transfer of their offices and landing places from lower to upper docks. A knowledge of slight rises is often of great value, as these frequently permit large freight movements by water. Lumbermen cut much timber in the swamps and along the streams during low water, looking to the rises to carry out their logs; advance information of coming stages enables them to have everything in readiness to execute their work without loss of time when the favorable conditions arise. During rising water those in charge of locks, dams, and levees are alert to the need of strengthening and protecting the property under their care; exact forecasting guides their operations as to time, place, and amount of protection, or may save them from expending money and effort in protective measures that will not be required.

During flood periods seiners and gill netters are guided by the river forecasts, as different kinds are needed for different stages of water. Fishermen in the Columbia River claim that the water stage seems to have some effect on the entrance of salmon from the ocean, and that by watching the river forecasts, a spurt in the run of fish can be predicted with a fair degree of accuracy. Forecasts of low-river stages are not without considerable value to some interests. When the stage falls below a given height many water-power plants have their supply cut off; with ample notice, they can have their auxiliary steam plants ready for use, and thus continue their business without interruption. Dock building, pile driving, dredging, and repairing are largely done during low-water stages, previous notice of which enables engineers to arrange for such operations.

In recent years, special reports have been issued for aviators. Also the daily weather map includes a statement concerning flying conditions. In connection with the train-plane transportation service inaugurated between New York and Los Angeles in July, 1929, by the Transcontinental Air Transport, Inc., in conjunction with the Pennsylvania and the Santa Fe Railroads, the United States Weather Bureau co-operated with the T. A. T. and a network of 83 weather reporting stations stretching across and to both sides of the entire route, enabled daily reports to be compiled and transmitted at each of the main line stations, and the weather hazard of flying to be reduced to a minimum, reports even being sent aloft to pilots by means of a two-way radio communication system installed on all planes.

CHAPTER IX

LANDS AND THEIR UTILIZATION

Geographic Factors of Land.

Major factors.—The relation of land to man's distribution and activities involves environmental factors like (1) place or distribution of land, (2) area of land, (3) shape of land, (4) accessibility of land, (5) remoteness of land, (6) surface features of land, (7) coasts or margins of land, (8) insularity of land, and (9) resources of land. While these factors are not mutually exclusive in all cases they are, nevertheless, sufficiently different in character to warrant individual discussion.

Foundational aspect of land.—The geography of the land begins with the principle that land serves as a foundation or stage on which man lives. It represents man's habitat, where he conducts or originates his varied activities. Indeed, man travels on the water of the earth, over ice, and through the air, but these activities are relatively minor in comparison to those on land.

However, not all land is suited as a stage for man's home and activities. One reason for the lack of human occupation on some land is its position or distribution.

Distribution of land.—An interesting situation concerning the distribution of the lands of the earth is the *concentration of land in the Northern Hemisphere.* The one exception to this arrangement of lands is the presence of Australia and the Antarctica continent or islands in the Southern Hemisphere. The land in the Northern Hemisphere forms an almost unbroken ring around the north pole. Nearly three-fourths of all land is in the Northern Hemisphere, or more than twice the land area in the Southern Hemisphere.

The effect of the vast land masses in the Northern Hem-

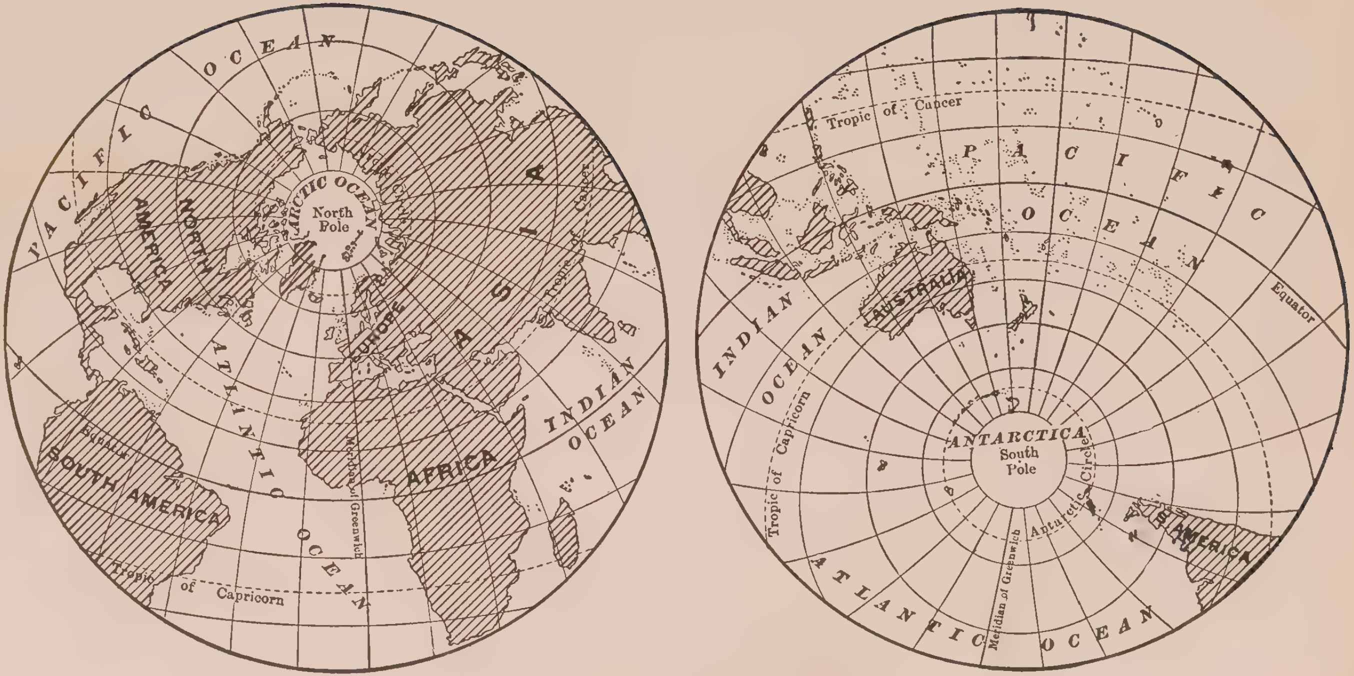

Fig. 65.—Land and Water Hemispheres.

isphere is revealed in the variability of climate so favorable for intensive and diversified social activities. Also the continuity of the land in the Northern Hemisphere is important in encouraging the migration of races, the contact of peoples, and the exchange of ideas and customs. In the Southern Hemisphere the opposite conditions are true. There, the predominance of water over land accounts for a uniformity of climate which tends to make human life inactive. Moreover, the position and non-continuity of the land are responsible for isolation and a lack of rapid progress.

Another striking phenomenon in regard to the distribution of land is its concentration around a given center, namely, England. It is found that six-sevenths of all land falls within the so-called *Land Hemisphere* of which England occupies the center, whilst six-sevenths of all water is within the Water Hemisphere of which New Zealand occupies the center.

The geographic importance of these Land and Water Hemispheres can be readily seen. England occupies a strategic position, in being centrally located in relation to nearly all the lands of the earth. Her maritime interests have been favored by having so advantageous a location. The success of Great Britain can be attributed in part to her ideal central situation. New Zealand, on the contrary, is in an isolated position. Her social contacts have long been few. This has greatly retarded progress and encouraged provinciality among her inhabitants. True, the degree of isolation is less to-day, with the modern means of transportation by air and water, than it was during the days of the sailing boats, but there is still a marked degree of isolation.

A third noteworthy fact is that on the opposite side of the globe from each continent is an expanse of water. North America lies opposite the Indian Ocean. (See Fig. 135.) The continents of Eurasia and Africa are antipodal in position to the southern Pacific Ocean. Australia lies opposite the widest part of the North Atlantic Ocean. South America is an exception to this arrangement; its southern extension lies opposite part of eastern Asia. The great Antarctica continent is at one end of the earth's axis and the Arctic Ocean at the other end.

Shape of lands.—The shape of land or the form of the boundary of land, whether it applies to a building lot, a country, or a continent, is a matter of considerable geographic importance. For business or residential purposes, a rectangular lot is generally preferred to a square lot of like area. In the subdivision of land for realty development, the tendency is to lay out the tract in rectangular plots in order to have a maximum number of lots with street or water frontage.

The country of Chile is a good illustration of the effect of the shape of land on human activities. The Chilean territory extends a distance of 2,600 miles along the western coast of South America, while the width of the country averages less than 110 miles. This latitudinal dimension of Chile introduces a wide range in climate, a condition which in turn is accompanied by a corresponding difference in man's occupation. In time of military operations, land area such as that of Chile would be more difficult to protect from invasion than a country such as Uruguay whose compactness of land is characteristic of its shape.

The *triangular shape of the continents,* in being broad in the northern parts and tapering toward the south in the southern parts, places a greater portion of the land masses, in the Southern Hemisphere, under tropical activities, while the lands of the Northern Hemisphere offer temperate conditions. Also the continuity of the continents in the Northern Hemisphere, which tends to prevent isolation, is a result of the shape of the land, and has important effects on man's distribution and his activities.

Relation of the area of land to human life.—Since man's home is confined, primarily, to the lands of the earth, it seems almost self-evident that the amount of land is an important and vital geographic factor. The *total area* of the earth's surface is approximately 197,000,000 square miles. Nearly three-fourths of this area is covered with water, the area of the oceans being about 145,000,000 square miles, and the *land area* about 52,000,000 square miles. These land and water areas are relatively constant so far as any changes are concerned in the course of human history. During the past one hundred and fifty years, men of science have obtained sufficient evidence to be able to say that notable changes in the size, form, and relief of the earth's surface require hundreds of thousands of years.

At one time, it was thought that mountains, canyons, and great valleys were created by great catastrophic disturbances or forces in a short time. This idea has been wholly discarded. It is probable that mountain ranges have been uplifted and deep valleys cut since the beginning of man, but it is also likely that these *changes have been slow* and imperceptible. In the course of geological time, which involves millions of years, mountains have been uplifted and completely worn down repeatedly. Arms of the sea once covered what are now land masses, but man was not a factor of that environment. Possibly, the only great episode that even prehistoric man witnessed was the *Great Ice Age* which closed some 35,000 to 60,000 years ago. The rate and nature of change in the surface of the earth as manifested to-day are very likely representative of the modifications that have taken place throughout human history; while the surface of the earth has changed its appearance in detail, the broader aspects, such as the size of the continents, their major surface features, the distribution of land and water, the major streams, and the like have remained unchanged for countless generations.[1]

Modifications of land by man.—But the forces of nature are not the only agents possessed with the power of modifying the land environment. Man also is an effective sculptor and molder of the earth's landscape. By efficient drainage systems, man has been able to reclaim thousands of acres of land.

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[1] In part adapted from Professor O. D. Von Engeln's book, "Inheriting the Earth."

Nearly three-fifths of the land surface of the Netherlands has been made habitable through man's work of reclamation. From 1848 to 1852, seventy square miles were made dry by draining Lake Haarlem. In 1918, work was started in controlling and draining the Zuider Zee, by means of which about 800 square miles of cultivated land will be added to Dutch territory. In the United States, the reclaiming of swamps, tidal marshes, and the like has progressed slowly. It was reported that in 1920 there were 91,543,000 acres of land in the United States unfit for cultivation without drainage. Equally extensive areas in need of drainage are found in Canada, Russia, the tropical countries of Latin America, and the Far East.

The *prevention of river floods* would also increase the area of land suitable for the home of man and his activities. It is likely, however, that the reclamation of land will take place more or less in proportion to the demand and value of the land. In densely populated regions or centers, every economical means is tried to increase the area of the land. Rivers are straightened, deepened, and made narrow, and even completely eliminated by filling, in order to utilize more efficiently the limited lands. The construction of buildings with ten, thirty, and fifty stories, is a further indication of the human adjustment to the environmental limitation of land in certain areas.

Large land area considered an advantage to a nation.[2]—On purely geographical grounds, the larger the area occupied by a race or people, other conditions being equal, the surer the guarantee of their permanence, and the less the chance of their repression or annihilation. A larger area offers protection by its mere distances; renders attack difficult and affords room for retreat under pursuit. On the other hand, a small area is easily traversed by the invaders and its inhabitants are soon brought to bay. Russia and Belgium are illustrations of a large and small area, respectively, and as a result experienced the conditions as stated during the late World War.

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[2] In part adapted from Miss Semple's book, "The Influences of Geographic Environment."

Again, since land is primarily the basis of society, it tends to follow that the broader the land, the greater the *diversification of resources,* the more variety in its climate, and the more varied its social contacts. For example, consider the different environments found in a vast and varied continent like Eurasia which extends from the equator far beyond the Arctic Circle, as compared with a small land-mass like Australia, relatively monotonous in its geographical conditions; and observe how much farther human progress has advanced in one than in the other. The world-wide expansion of the British Empire has resulted in an extensive social contact and great progress. The larger the area brought under one political control, the less the handicap of internal friction and the greater its economic independence. Vast territory has helped greatly to enable the United States to maintain with advantage a protective tariff, largely because the free trade within its own borders is extensive.

Some of the *influences of a small area* on national policies and conditions are disclosed by the country of Japan; such as excessive population, aggressive expansion, and restricted modes of living. Many of our cities show the same results due to limited areas, as, for example, the crowded streets and sidewalks, the congested housing conditions, the difficulty in finding a parking place for your automobile, and general hurry to make room for some one else.

Influence of the accessibility and remoteness of land.—The degree of ease and length of time involved in man's migratory activities are of no minor geographic importance. Whether man must travel across water or land, and spend one hour or six hours on his journey, may determine the nature of his disposition, finances, and contentment. These conditions of proximity and isolation have been factors of vital significance throughout human progress. Man has always followed *the path of least resistance* in the long run.

Barriers, whether mountains, oceans, seas, lakes, deserts, or forests, have retarded expansion from within and the accession of people from without. Where no barriers exist greater likeness of people prevails, and generally greater homogeneity of customs and progress. It has been pointed out by scientists that the long stretch of coastal lowlands encircling the Arctic Ocean and running back into the wide plains of North America and Eurasia shows a remarkable uniformity of animal and plant forms and a striking similarity of races.

Where lands offer little diversification, there are few ethnological differences. Where the continents converge there is found similarity or even identity of race, easy gradation from one type to another; where they diverge most widely in the peninsular extremities of South America, South Africa, and Australia, they show the greatest dissimilarity in their races and a corresponding diversity in their animal life. Miss Semple says: " Geographical proximity combined with accessibility results in similarity of human and animal occupants as well as occupation, whilst a corresponding dissimilarity is the attendant of remoteness or of segregation."

Influences of the surface of the land.—The nature of the topography or relief of the land is another important environmental factor, one that nearly every person experiences daily. Whether the land is level or irregular, high or low is a matter of material difference in human progress. The principal factors involved in these land-form influences are discussed on the basis of the classification of the land into its major features; such as, mountains and hills, plateaus, plains, and valleys. In this study, a conscientious use of physical and political maps will facilitate a better understanding of the relation and influences of land forms on man's distribution and his activities.

Geographic Circumstances of Mountains.

Individuality of mountains.—One of the foremost characteristics of mountains is individuality. Their expression is peculiarly inherent, as that of human beings, in that one seldom finds two alike. Also, like man, they are generally found in groups or in larger communities, known as ranges, systems, or cordilleras. The term, cordillera, is applied to groups of mountain systems; for example, the cordillera of the western United States includes the Rocky Mountain system, the Sierra

Nevada, and the Coastal Range. A system of mountains has reference to a group of mountain ranges, and a range represents a group of individual mountains. Then, again, an individual mountain may consist of several prominent components, such as peaks, ridges, cliffs, disconnected depressions, and valleys. The latter feature (valley) is found not only in individual mountains, but also between mountains, and it is the site of greatest human importance in these elevated land masses. The height of a mountain may be a few hundred feet or many thousands of feet above sea level. The slopes of mountains may be steep, gradual, rounded, flat or step-like. Hence it seems quite evident that it is practically impossible to give a definition of mountains that is representative in all cases. However, in the broadest aspect, mountains may be defined as conspicuous elevations of limited summit area.

Mountains and hills.—Mountains cannot be distinguished from hills on the basis of absolute elevation or mass. For example, the Allegheny Mountains are much lower than the Black Hills, but they are the most conspicuous elevations in their sections; whereas the Black Hills are apparently small as compared with the towering Rocky Mountains. Thus, it can be said that the terms, hills and mountains, are comparative in meaning, in most cases, although there are definite land forms that can be distinguished as hills without applying the comparative idea, such as the glacial deposits called drumlin hills and sand deposits called sand dunes or sand hills.

The major reasons why mountains differ depend upon (1) the nature of their origin, (2) the composition of their rock, particularly their resistance to erosion, (3) their age, (4) the rate and type of destructive agents affecting them, and (5) climatic influences.

Types of mountains.—On the basis of physical activities, mountains may be classified into types, known as (1) folded, (2) step or block, (3) volcanic, (4) erosional, and (5) combination of folded, step or block, volcanic and erosional. An understanding of the characteristics of these types is essential in the study of the geography of mountains.

Folded mountains.—These present largely parallel ranges and valleys. The rock layers of these mountains have slowly been pressed into a series of wavelike folds. The great mountain systems of the world are of this type. One of the best examples of folded mountains is the Jura mountains, between France and Switzerland. The Jura mountains have been slightly modified by erosion. The upper layers of the folds have been removed and the valley floors covered with rock waste, but the drainage of the region is controlled by the form of the mountain. Small streams flow down the steep sides and enter the main streams in the valleys. The slopes of these mountains are wooded. Villages have grown up and activities thrive in the valleys. Isolation, however, may be a limiting factor in the valleys of folded mountains. But generally transverse valleys exist, leading from one longitudinal valley to another, which offer accessibility. Moreover, the valleys are seldom closed at the ends, thus offering accession in the direction of the folds.

The Appalachian mountains are also recognized as folded mountains. The structure, however, is extremely variable in many places. The mountains are eroded so that the original summit lines have entirely disappeared, and the present ridges are the outcrops of resistant rocks, that have withstood the action of weathering. Again, the valleys are the centers of agriculture whilst on the mountain sides are thriving coal mining areas.

Faulted or block mountains.—In mountainous regions there are numerous illustrations of breaks or faults in the earth's crust. Subsequent uplift or sinking has resulted in the formation of mountain ridges, steps, or blocks. Frequently the slope on one side of the fault or crack is steep and on the other side it is gentle. As suggested by the names, these mountains resemble steps or blocks. The Great Basin region of North America has been formed by a series of faults. There are many such mountains in southern Oregon. The loftiest range in the United States, the Sierra Nevada, is an uplifted fault block. Population on block mountains is generally scanty, for the region repels settlers. A few ranchmen make their homes there, tending the cattle and sheep grazing on the grass that grows on the mountain slopes. The slight rainfall of this type of mountainous region is one of the characteristics of block mountains. The valleys in block mountains are broken and disconnected. Streams are few, and generally intermittent; that is, they flow only a part of the year, their beds being dry at other times.

Volcanic mountains.—Volcanic mountains are frequently the high isolated land forms. Some are distinctively cone-shaped, but others are massive with less prominence. The volcanic cones have been formed by the accumulation of material erupted from their vents, such as Vesuvius and Etna. In some cases, volcanic mountains consist of a group of domes formed by the intrusion of lava beneath horizontal layers of bed rock, which have been lifted to a great height and later eroded. The Henry mountains of Utah are excellent examples of domed volcanic mountains. Mt. Hood, Mt. Whitney, and Mt. Shasta are other illustrations of volcanic mountains. On the slopes of volcanic mountains may be found active settlements, working the fertile volcanic soil. There is very little life on the summits of lofty volcanic mountains, for many of them are covered with snow and ice the year around.

Erosional mountains or dissected land masses.—There are many mountains which are due to the resistance of their rocks which have been left standing by the removal of the surrounding weakened rocks. Nearly all mountain peaks are the resultant of resistance. Pike's Peak, Colorado, is a good example. The Catskill mountains of New York are a part of a dissected plateau. In reality, the Catskill mountains should be recognized as a dissected plateau rather than a mountain.

In addition to the folded, block, volcanic, and erosional mountains which have been classified according to the predominance of some one process of origin, there are mountains which involve a combination of all of these types. Furthermore, the continuous changes in mountains may completely destroy their characteristics as determined by origin.

Age of mountains.—The well-known expression " Old as the Hills " does not characterize the nature of the elevated land masses. They are constantly under the influence of modifying agents. As mountains are forming (an extremely slow process, probably occupying millions of years), they are subject to disintegration or destruction. Mountains, as we see them to-day, show evidences of erosion and weathering. Their peaks have been carved out of rock of wavelike folds and domes, their ledges and cliffs have been formed by physical and chemical processes of weathering; and their slopes have been scarred and gullied by mountain streams and glaciers. While the extra-terrestrial forces are active in reducing the mountain mass, there may also be uplifting forces in play to increase the height of the mountain. Thus mountains are acted upon by two forces, one tending to make them lower, and the other striving to make them higher; one acts from without the earth and the other from within the earth. As a result of these forces, mountains may be classified according to their characteristics, as young mountains, mature mountains, and old mountains.

Young mountains.—Young mountains are characterized by irregular sky line, bare ledges, steep slopes, torrential streams, frequent landslides, avalanches, and earthquakes may occur at times. The difficulty in traversing young mountains is almost self-evident. Human activities are confined, primarily to the V-shaped valleys where limited farming areas and an abundance of water power may be found.

Mature mountains.—Mature mountains have low, rounded forms, few bare ledges, uniform slopes, wide open valleys, and valleys cutting across the divides forming important passes for transportation purposes. Earthquakes, landslides, and avalanches are few or unknown. The area of habitable land is far greater than the amount found in young mountains. Accessibility also favors general activities in mature mountains, which are thus more favorably blessed with natural advantages than young mountains.

The Rocky mountains are younger mountains than the Appalachians. The Rocky mountains rise 8,000 or 9,000 feet above the platform on which they rest, the Appalachians 900 to 1,200 feet. The Rockies have a very irregular sky line, the

Appalachians disclose a more even sky line. The streams in the Rockies are swift, those in the Appalachians have a more gentle slope. Earthquakes, landslides, avalanches occur in the Rockies but not in the Appalachians.

Old mountains.—As mountains are reduced in height and mass, they may appear a remnant of the original elevated land mass, known as monadnocks because of differential erosion or resistance to destructive agents. Mt. Monadnock in New Hampshire is an illustration of one of these isolated land masses on the peneplain of New England. The region south of Lake Superior is an old mountain region. The Laurentian highland illustrates the characteristics of old mountains.

Mountains and climate.—Although the subject of mountain climate has been discussed elsewhere in this text, it is mentioned again for reasons of emphasis. Mountains are profoundly effective in modifying the meteorological conditions of the atmosphere. Mountains deflect winds, changing their direction and bringing rain to regions that would not have it under other conditions; cause precipitation in certain areas and desert conditions in others; reduce the temperature of the air; create local winds; and, in general, produce atmospheric conditions that are of latitudinal significance because of altitude.

Vegetation is the fairest indication of the effect of mountains on climate. For example, the timber line and snow line are more or less irregular, being usually higher on the south or sunny side of east and west ranges than on the shady side. In the equatorial region the snow line is about 18,000 feet above sea level, but its altitude becomes less as the distance from the equator increases reaching sea level in the polar regions.

Mountains as barriers.—Mountains (1) are often effective *climatic barriers,* (2) check the migration of animals and the distribution of plants, and (3) retard the exploration, settlement, and development of many lands. On the leeward side of mountains are sometimes found dry or desert lands, because the air blowing over the mountains has lost its moisture and descends as a dry and evaporating wind. The Atacama desert of Chile and Peru and the semi-arid and desert lands on the eastern side of the Rocky Mountains are illustrations of the effect of mountains on the climate of adjacent land. Also, the low temperature of many mountains prevents the distribution of biological elements. The difference in flora and fauna of regions is often due to mountain barriers.

Then, mountains influence *the movement of people.* The Appalachian mountains delayed the settlement of the central plains by the English. The Rocky mountains confined the interest of the Spanish settlers primarily to the Pacific-coast region. In the east, the Berkshire Hills lying between Boston and Albany deflected the early trade of the central plains and lake region coming into Albany by way of the Mohawk valley down the Hudson valley. By the time a railroad was built between Albany and Boston, the city of New York had become firmly established as the leading port.

Mountain passes.—The effectiveness of mountains as barriers depends upon their height and structure; whether they are massive and unbroken as the *Pyrenees* and the *Andes* or like the *Alps* and *Brazilian Highlands,* pierced with numerous valleys and passes. The Pyrenees separate Spain from France with greater exclusion than the Alps divide Italy from France, owing to their compact character, forming the most definite natural boundary in Europe. The Alps have a number of passes, evenly distributed, as well as great longitudinal valleys which offer transit routes from side to side in every direction. This is also true of the *Appalachians,* with their longitudinal valleys and many gaps among their parallel ranges offering routes in all directions, although the Appalachian system is some three hundred miles broad and thirteen hundred miles long.

The *Rocky Mountains* and the Andean mountains are examples of height and massiveness. They have few passes, thus forming an effective barrier. Other features being the same, mountains are barriers in proportion to their height; for with increased altitude there is also an increase in the harshness of climate. Old worn-down mountains, like the Appalachians and the Ural, broad as they are, have been less effective barriers than the towering crests of the Alps and Caucasus. The form of the elevation is also a factor. Gentle slopes and rounded summits make easier transit regions than high, thin ridges with escarpment-like flanks. Mountains of plateau-form, although reaching great altitudes, may be regions of intensive nomadism.

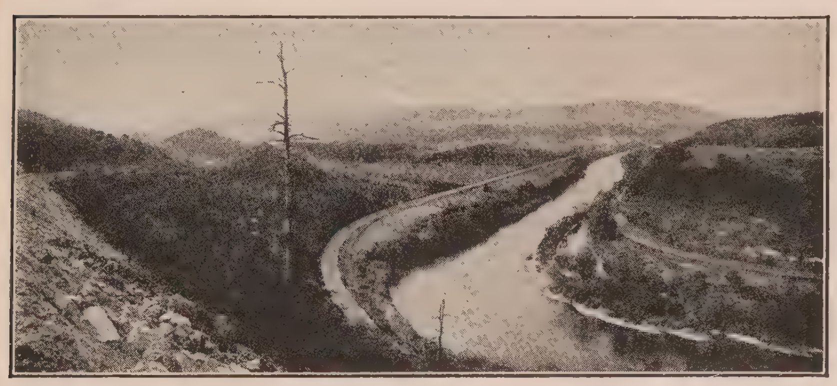
In view of the general difference in the climate of various parts of mountains as well as the diversity of form, one seldom finds the *accessibility of mountains* the same from all sides. There may be a steep difficult approach to the summit from one direction, and a longer, more gradual and hence easier ascent from the other side. This may mean a wider zone of habitation and industry on the gentle slope and hence better facilities for ascent than on the other side where natural conditions are less favorable for human activities. Even in the present day it frequently takes two engines to pull the train up one side and only one if the same train is making its ascent from the other side.

In the construction of the Canadian Pacific Railroad across the continental divide of the Rockies it was necessary to dig a loop tunnel in order to take care of the difference in grade between one side of the mountain and the other. The trans-Andean railroad passes through a tunnel constructed across the divide to overcome the difference in grade on the two sides of the Andes. This difference in slope has also an ethnical and political as well as commercial importance in the geography of mountains.

Human interest centered at mountain passes.—Hence for migratory humanity, the interest of the mountains is centered in the passes. These are natural openings from one valley to another. They may be mere dents in the crest of the mountain, formed by faulting or movement of the earth's crust or cut by streams, glaciers, or winds. Then again, they may be deep gaps in the mountain ridges even extending from the floor of one valley to that of another, such as the Delaware Water Gap.

The influence of passes is far-reaching. They may determine the political strength of a nation during military engagements, and commercial supremacy in times of peace. The Khyber Pass leading from India into Turkestan and Persia has from time immemorial guided warlike nomads from their regions of poverty into the fertile fields of India. The passes between the Mediterranean and Northern Europe have been important foci of European history. The St. Bernard, the Peartree, the Brenner, the St. Gothard, and the Simplon pass are all worthy of attention and should be accurately located.

In the United States is found the famous South Pass in the Wyoming Rockies which has directed the course of man for centuries across the lofty mountains of the Pacific.



Courtesy of the Baltimore & Ohio R. R. Co.

Fig. 66.—The Baltimore & Ohio Railway, the Chesapeake and Ohio Canal, and the Potomac River. These arteries follow the valley through the mountain pass, which is also occupied by the town, the farm, and the highway.

The importance of passes depends not only upon the nature of the gap or depression, but also involves the *character of the regions connected* by the pass. Diversification of products and inequality of people, in regions separated by mountains, may favor the greater utilization of a connecting pass than in the case of a pass joining regions of likeness. The passes of the Alps have been active since the early middle ages because they favor the exchange of commodities between the tropical Mediterranean regions and temperate regions of central Europe. The Mohawk pass carries the grain of the northwest to the manufacturing centers of the Atlantic seaboard.

The influence of passes has varied considerably but, with few exceptions, *they have not lost their importance* because of the improvements in transportation. Miss Semple says, "They are nature-made thoroughfares, traversed now by undisciplined hords of migrating barbarians, now by organized armies, now by the woolly flocks and guardian dogs of the nomad shepherd, now by the sumpter mule of the itinerant merchant, now by the wagon-trains of over-mountain settlers, now by the steam engine panting up the steep grade." And now the *aviators* are directed by these natural cuts to the most advantageous places to cross the mountain barriers.

Habitability of mountains.—In the early days of man, mountains were viewed with horror as sites of evil spirits and ill-doings. They were recognized as transit areas, like desert and sea. Possibly the first of human activities in mountains concerned their value as regions of seclusion, where man might be free to execute his religious practices, or hide from the hands of the law. Protection is also a likely attribute that man early recognized. The strategic importance of mountains is still foremost in military behavior. It has been said that the New Englanders settled on the hills rather than in the more fertile valleys because of the natural advantages of protection afforded by elevated lands. However, with few exceptions, mountains are areas of late habitation, progressing in this respect in accordance with necessity.

Mining an important mountain industry.—Mountain building has favored the formation and exposure of mineral deposits. Nearly all of the minerals that occur in veins are found in disturbed land masses; in young as well as in old mountains. The great number of underground passages, the large volume of circulating water, the high pressure and temperature of the internal water account, in part, for the fact that most of the concentrated mines of ore occur in veins in mountains. Even the minerals that occur in beds, rather than veins, including such as coal, iron, and salt are frequently found in uplifted and faulted areas of the earth.

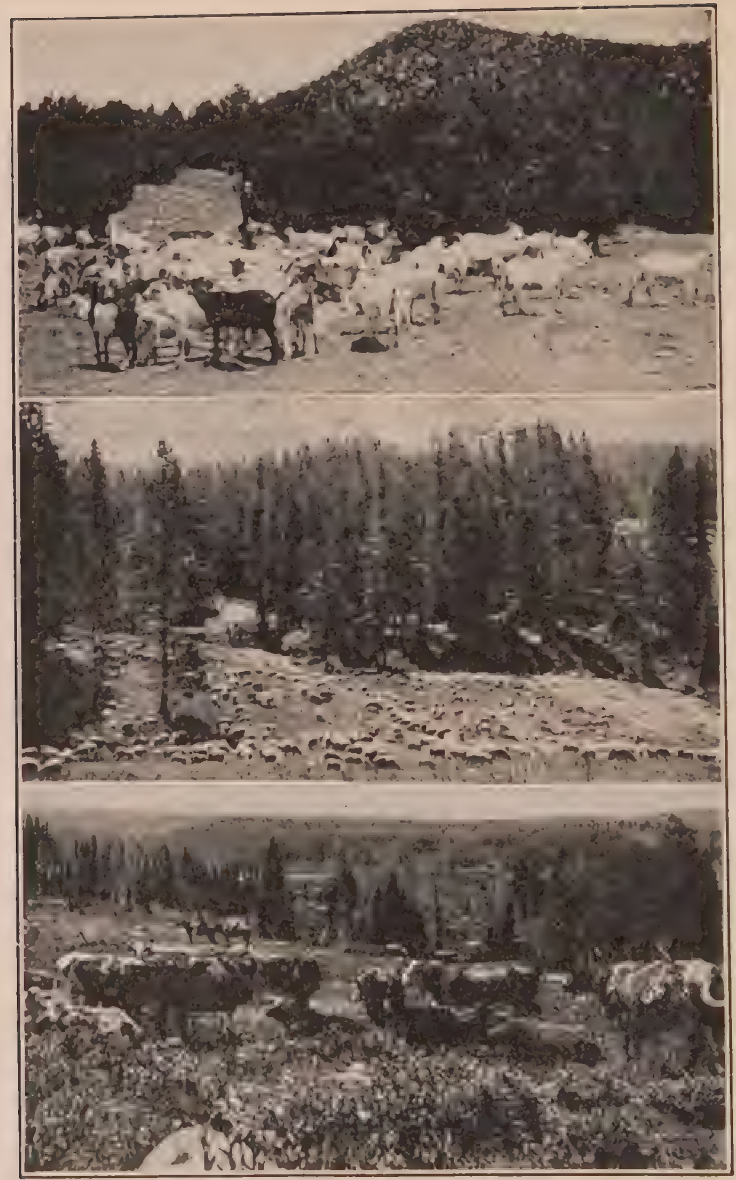
Mountain-making processes are associated not only with the formation of some minerals, but also with their accessibility. The deep strata or zones of rocks are uplifted, folded, faulted, and eroded; thus disclosing the treasures of the earth which otherwise would very likely remain unknown to man.

The nature of the mining communities depends very largely upon elevation, climate, and type of mining. The permanency of the supply of ore, the market price, competing materials, labor, and the like are factors of importance which must be considered in determining the character of the mining industry. A more detailed account of the geography of minerals is given in a later chapter.

Mountain agriculture.—The *valleys* in mountain ranges are often the seat of productive agriculture, but the farmers are confronted with isolation and difficulties of transportation. As a result their influence is primarily local. The mountain slopes are naturally unsuited for extensive agriculture, but intensive and specialized farming has been successfully conducted by terracing the slopes. Terrace agriculture has been practiced for decades in Germany along the steep slopes overlooking the valley of the Moselle and Rhine. There are extensive areas of agriculture conducted on terraced slopes in the Vosges mountains, the Black Forest, and the Alps. Terrace cultivation prevails in Italy, on the gentler declines of the Apennines and along the Riviera and the Maritime Alps.

In the Himalayan land, *terrace agriculture* is widely distributed. Peru, Japan, China, and Java are some of the other regions of the earth in which mountain terracing is extensively practiced with considerable importance. In California, on the foothills of the eastern slopes of the Coastal Range are numerous examples of terrace agriculture. In most cases, grape vines are synonymous with terrace agriculture but other crops, including such as hemp, rye, corn, oats, flax, rice, and various tree crops are successfully cultivated on terraced fields.

The excellent *grasslands in mountains* furnish pasturage during the summer. As a result the grazing industry is a representative phase of agriculture in the highlands of the earth. Where the steepness or rockiness of the soil, coldness and shortness in growing season restrict or eliminate the cultivation of crops, grazing is the predominant industry. The area of pastures far exceeds that of arable land in mountain regions.



Courtesy of U. S. Forest Service.

Fig. 67.—The Grazing Industry of Highlands.

Upper.—Goat herd in the Santa Fe National Forest, New Mexico. (Photo by E. S. Shipp.)

Middle.—The forest provides abundant cover on the watershed and affords excellent pasture. Gallatin National Forest, Mont. (Photo by K. D. Swain.)

Lower.—Cattle grazing on high summer range, Grand Mesa National Forest, Colorado. (Photo by W. J. Lubkin.)

The utilization of these pasture lands has developed the well-known pastoral nomadism.

Cattle, sheep, goats, lambs, and other animals are started on their mountain pilgrimage as soon as the snow has uncovered the succulent grass. They advance to higher altitudes as the snow line recedes. They remain in the mountains, until the fall snows compel their descent to their permanent home in valleys or plains. In some cases, especially in Switzerland, entire families may move to homes in mountains, where they carry on their form of agriculture, returning to their winter homes after the harvest seasons. The migration is not only from plains or foothills into mountains but also from intermountain valleys to valleys at higher elevations in the mountain.

Mountain agriculture can be recognized *first,* as the result of the scarcity of agricultural or arable land; *second,* the presence of cheap land; *third,* the utilization of cheap animal food; and *fourth,* one or more of all three factors combined.

Supplementary mountain occupation.—In mountainous regions where the agricultural resources are scant, the cropping season short, the winters long and severe, the result is frequently that the farmers have an abundance of leisure time and an insufficiency of financial support. Hence, their attention is often turned to some supplementary occupation for remunerative and time-consuming purposes, especially during the confining winter months. Native *household industries,* therefore, have developed in great numbers and varieties in these isolated highland areas. The industries are naturally based upon the local raw material, such as wood, metals, wool, clays, and the like, with the production of articles of small bulk and large value to overcome the cost and difficulty of mountain transportation.

In the Swiss and Scandinavian countries, *wood-carving* is a representative industry of artistic character. In the Black forests and the Jura mountains, *watch and clock making* are conducted with marked skill. In the central Apennines, the peasants are versed in the making of some of the finest violin strings known. The inhabitants of low Thuringian and

Franconian forests have turned their resources to the *making of dolls,* glass articles, porcelains, majolica, and terra cotta. In Asia, the Tibetan is a maker of jewelry of pronounced value and finery, and the native wool is spun into cloth of extraordinary quality. So also, the curing and tanning of furs is practiced extensively in mountainous regions.

Mountain forests.—Mountains have to some extent acted as natural forest reserves. In the more accessible regions, the timber supply has been reduced to a minimum in order to make way for progress as well as to supply fuel and lumber. But the irregularities of mountain-land have checked this human invasion with a marked degree of effectiveness. Mountains are not easily traversed, and not well suited for agriculture but, as a whole, are excellent timber reserves. As a result by far the greater percentage of the forested areas to-day are found in mountains.

The governments of France, Germany, Sweden, United States, and other countries have set aside many thousands of square miles of land as *forest reserves* and a large part of this area represents mountainous regions. Forests not only utilize most efficiently the mountain-slopes of difficult accession but also conserve the rainfall and tend to make the streams more permanent in their flow throughout the year, thus preventing excessive run-offs and resultant floods.

Water resources of mountains.—The existence of water power depends upon (1) the volume of surface water and (2) the land-forms. These environmental factors are generally best developed or combined in mountains. Hence, mountains may well be considered as natural water reservoirs; but, due to the increasing numbers and activities of man, it has become necessary to aid mountains in providing better water storage facilities. Streams have been barricaded in the construction of dams to conserve the surplus water for future use. In this conquest of nature, man is favored in his work by suitable reservoir sites; such as narrow and deep valleys, steep slopes, and active streams—the inherent characteristics of many mountains. As a result, mountain reservoirs supply water for human consumption, water power, and irrigation—three important phases of the utilization of water. With the increasing demand for water in the rapidly growing cities, the long distance transmission of power, the marked interest in land reclamation by means of irrigation, and the activities involved in the conservation of mountain water, the future is destined to bring far greater interest in the economic significance of mountains in supplying the human necessity, water.

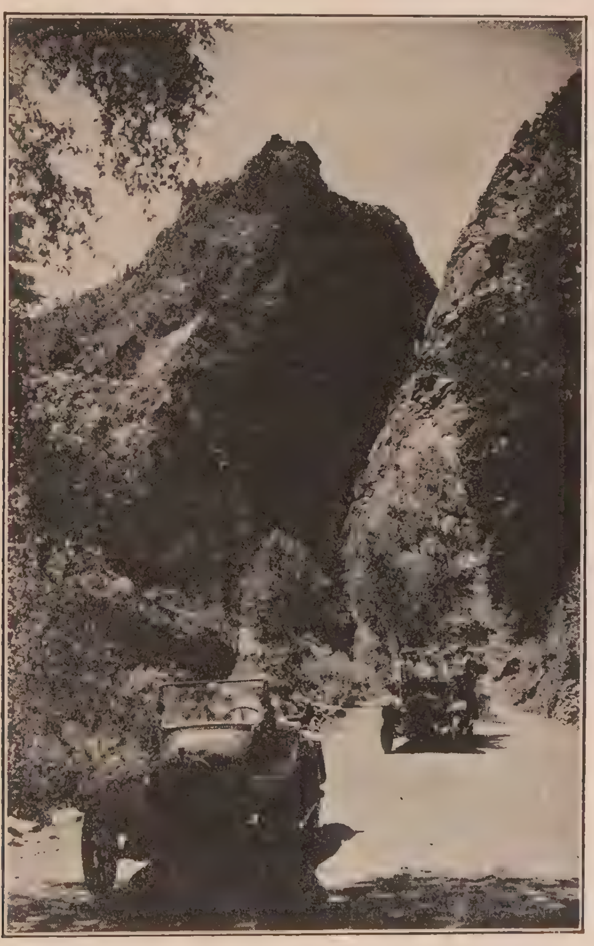


Photo by F. E. Colburn courtesy U. S. Forest Service.

Fig. 68.—Pillars of Hercules, South Cheyenne Canyon, Pike National Forest, Colorado.

Mountain resorts.—The invigorating atmosphere, the beautiful scenery, and the inviting seclusion attract thousands of people to the mountains each year. The Alps, Canadian Rockies, and the Appalachians are only a few of the mountainous areas where the business of caring for the health and the pleasure of its visitors has reached a degree of tremendous importance.

Mountains are full of hidden treasure which is revealed at every turn. They do not disclose their character harmoniously and at a glance, as is the case of regular land forms. They stand for health, strength, and beauty. Nearly everyone loves the mountains.

Plateaus and Life.

Nature of plateaus.—Plateaus possess the *characteristics* of both mountains and plains. In elevation, they have the attribute of mountains while in their table-like or broad surface area, they display the character of plains. In fact, the term "plateau" is sometimes applied to regions which are better classified as mountain or hill country and sometimes as plains; e.g. the Laurentian Plateau, the Piedmont Plateau, the Allegheny and Cumberland Plateaus, and the Ozark Plateau might perhaps better be called mountains. A detailed examination of a topographic map will reveal the facts.

A true plateau is generally recognized as (1) an *elevation* above sea level of from 2,000 to 15,000 ft.; those about 8,000 ft. above sea level are considered medium plateaus, while those about 15,000 ft. above sea level, are considered lofty plateaus, (2) an *extensive summit area* that is table-like or relatively flat. Mountain ranges are generally found on at least one side and in many cases completely inclosing the plateau. Then, again, there may be plains or lowlands on one or more sides, whose flatness of surface is interrupted by mountain ridges, and deep canyons. At the base, or foot, of the adjacent mountain range are frequently found piedmont alluvial plains or fans, material in the form of fans carried down the mountain by torrential streams. The plateau has an "interior drainage" system consisting of streams having their head waters in the mountains and flowing on the plateau into lakes. These streams are often intermittent, that is, they flow only at times, and the rainfall is generally light or scanty in amount.

The *climate* of plateaus, like mountains and to some extent like all land-forms, depends upon latitude, altitude, exposure, direction of winds, and the like. Also, like mountains, the climate in various parts of the plateau may differ because surface characteristics and position are variable. Some of the well known plateaus of the earth are the Spanish Plateau, Abyssinian Plateau, Arabian Plateau, Plateau of Iran, Plateau of Asia Minor, Colorado Plateau, Colombia Plateau, Plateau of Bolivia, Plateau of Mexico, and the Tibet Plateau.

Life on a plateau.—The human activities on a plateau are governed largely by its location. Since climate is the apparent predominant factor, and since climate depends in part upon elevation, it must necessarily follow that the full significance of plateaus is found in tropical regions, where highlands represent the seats of the greater concentration of population. From Mexico to central Chile, the chief centers of population appear above 3,000 feet above sea level. In Mexico, the Central plateau harbors more than two-thirds of the total population of about 15,000,000. Ecuador has three-fourths of its population on a partly enclosed plateau at an elevation of 8,000 feet above sea level. Bogota, the capital of Colombia, and La Paz, the controlling seat of government of Bolivia, are located within plateaus. In Bolivia, 72 per cent of the total population live at an altitude of 6,000 to 14,000 feet above sea level. Plateaus have been referred to as the white islands of the tropics because nearly all of the permanent white population in the tropics live on plateaus, if these land-forms exist within their reach.

Character and Geographic Importance of Plains.

Plains as centers of social activities.—Plains are the lowlands of the earth. They are relatively level stretches of land that may be but a few feet above sea level or several thousand feet above it, but nowhere are they distinctively higher than adjoining land or water. The continuity of their surface may be interrupted by valleys or ridges.

The geographical preëminence of plains over other landforms is attributed to their *traversable surface* and *workable soils*. Ethnical, political, and commercial expansion is encouraged by plains. They offer little geographical contrast and as a result uniformity in language, thoughts, and customs prevails in their realm. Few political boundaries exist on plains because nations have extended their claims to the lands of diverse form. Road building and the pursuit of other forms of communication have been favored by the relatively smooth surface of plains, although other conditions such as the absence of stone and the presence of poor drainage may offset the advantage of a level surface. Soils in plains are generally deep and easily cultivated with modern machinery, hence they constitute the agricultural regions of the earth.

Plains have not been favorable for the *early* development of manufacturing; because, (1) agricultural conditions have been inviting, (2) water power, forests, and mineral resources are generally lacking and (3) a diversified climate is usually absent. Thus, mountains or the piedmont, where these natural advantages for manufacturing exist, have been the early sites of manufacturing.

But man has acquired a knowledge of transporting raw material and transmitting electric power, so that the present regions leading in manufacturing are the plains. Large cities can be built here, with greater ease than in mountains, to house the large populations which are generally associated with manufacturing. Hence, *plains are primarily the home of man.* Nearly two-thirds of the total population of the earth live on plains.

Before passing, however, it should be mentioned that plateaus are the populated areas in the tropics. With increased efficiency in sanitation and drainage, and the growing population, it is very likely that the lowlands of the tropics will be the centers of population in the future. In time, the economic advantages of plains will overcome their adversity of climate, or it can be stated that the industrial advantages of plains will carry more weight than the favorable climate of the plateaus in the tropical regions.

Not all plains, however, are habitable, because plains differ in surface and soil conditions as well as in climate.

Classification of plains.—There are various bases that can be used in the classification of plains, such as their location, their climate, and their origin. On the basis of location there are the coastal plains, or plains near the coast, and inland plains or plains not bordering the coast. Then on the basis of climate, we have humid plains, desert plains, steppe plains, tundra plains, and the like. On the basis of their origin plains may be classified in the following manner:

1. River plains:
    - Old Alluvium.
    - Flood.
    - Delta.
2. Lake plains.
3. Glacial plains:
    - Rolling.
    - Rough.
    - Hilly.
    - Ice-scoured.
4. Piedmont plains.
5. Marine or Coastal plains.
6. Peneplains.
7. Aeolian plains.

Flood plains.—These are formed during floods by the deposit of sediment. When streams rise and overflow their banks, they submerge the adjacent lowlands and deposit material, such as gravel, sand, and clay. Since they are built by a broad sheet of water, their surface is generally level. They are usually highest near the river because that is where the velocity of the overflowing water is first checked and hence the greater deposit.

These higher portions of flood plains are known as natural levels. In many cases it has been necessary for man to build levees to prevent floods. The levelness, the depth, the uniformity of texture, the moisture, and fertility of flood-plain soils make these areas well-suited for agriculture. In some places, such as along the Nile flood waters, those floods controlled by man, as well as the natural floods, are means of irrigation to reclaim what would otherwise be desert land. Those areas of a flood plain which are no longer subject to inundation, but are built by flood water conditions at an early time, are called Old Alluvial flood plains or Old Alluvium plains.

Delta plains.—Streams flowing into lakes, seas, or oceans have their velocity suddenly checked, and deposits of sediment result. Some of the material may be carried away by currents or waves and some may remain which may eventually, with additional sediments, form land. These land-forms may be called delta plains. They are generally triangular in shape, as the Greek letter Delta, because the stream divides into several channels or distributaries, which enter the lake or sea by separate mouths. As deltas grow upwards and outwards, their upper portion becomes higher and drier and is commonly called a flood plain. Delta plains, like flood plains, are excellent farm lands; although delta plains are usually more poorly drained and the soil tends to be more of a sandy texture than in flood plains.

Both flood plains and delta plains are *densely populated* areas in many parts of the world. The delta of the Rhine is the home of the greater percentage of the population of Holland. The Nile flood plain and delta have nearly 700 persons per square mile. In China and India, millions of people live in these lowlands. The most objectionable feature of these river plains is their subjection to floods. Millions of people are said to have been drowned during floods in India and China. It is only necessary to think of the Dayton flood, the Mississippi floods, and the like to appreciate the danger of flood destruction on flood and delta plains. Nevertheless, they are densely populated.

Lake plains.—The sediment deposited in lakes tends to make their bottoms level. If the water is removed, the lake bottoms will appear as level plains. There are places where lakes have partly or completely disappeared. The Great Lakes were much larger than their present size. Hence, along their margins are level plains which once were covered with water. A large lake at one time existed around the Great Salt Lake. When the climate became more arid, the lake diminished in size due to evaporation, leaving lake remnants of which the Great Salt Lake is the largest.

During the glacial period, extensive lakes were formed by the interruption of drainage by the ice sheet. As the ice melted these lakes disappeared or nearly disappeared, leaving lake plains. The Glacial Lake Agassiz was a large lake of this kind, which existed in the Red River region. It was larger than the Great Lakes combined, covering an area of 110,000 sq. miles. The material carried into the lake formed a level, fertile plain which is the most important wheat region of Canada, if not of the world. Numerous other illustrations of lake plains are found throughout the world; some of these are described in other chapters.

Peneplains or worn-down plains.—Some large plains owe their levelness and low elevation to erosion. Once high and irregular, lands have been worn by weathering and erosion to nearly a uniform flat surface not far above sea level. Such plains are seldom as smooth as lake plains or flood plains but are broken in continuity by low rounded hills, composed of material less easily eroded, or less affected by the destructive agents. Where the erosion has been primarily the effect of ice these worn-down plains are called ice-scoured plains and have been classified under glacial plains.

Glacial plains.—Numerous plains have been constructed by glacial activity. Glaciers have made the surface in some places smooth or relatively so (1) by deposition, and (2) by erosion. The material carried or pushed along by the ice has been deposited as movement of the glacier stopped or as the ice melted. These deposits have been called drift or *moraines*. The nature of the deposit, as to whether it is smooth, rolling or hilly, characterizes the plain, such as a smooth morainic plain, rolling morainic plain, or hilly morainic plain. Not all glacial deposition has been spread out into the form of plains; some has been piled up into ridges.

The degree of levelness of morainic plains has a marked effect on agricultural practices. The hilly plains cannot be cultivated successfully, and are generally used for grazing purposes. The level, undulating morainic plains are the more desirable farming regions.

The erosional glacial plains are sometimes called ice-scoured plains. The glacial ice has removed the soil and eroded the rocks, leaving a very barren surface. Numerous lakes and swamps are found in such country. Agriculture is conducted with difficulty. Lumbering, fishing, and mining are the major industries on ice-scoured plains. The Laurentian region and parts of the Scandinavian areas are illustrations of ice-scoured plains.

Piedmont plains.—In arid and semi-arid regions where the soil is often not covered with vegetation and rainfall is largely torrential in character, stream erosion is generally intermittent in nature. During the sudden downpour of rain, water rushes down the mountain slopes, heavily laden with sediment and flowing with great velocity. But as the water reaches the base or foot of the mountain, its velocity is checked, and its sediment is deposited, frequently in the form of a fan. These deposits are called alluvial fans.

Where two or more fans coalesce they may cover an area varying from a few square feet to an extent of several square miles. These piedmont areas are called plains or piedmont plains. Their surface is generally interrupted by distributaries, in which water flows during the torrential rains or rainy seasons and which are constantly enlarging the plain. The slope of the plain is toward its outer margin away from its center of origin.

These piedmont plains are *important agricultural areas.* In California, we find alfalfa, wheat, and fruits raised extensively on piedmont plains. Usually, on account of air drainage or inversion of temperature, the more resistant crops, such as alfalfa, are raised at the lowest level of the plain, while on the higher portion the crops, such as oranges, which are less resistant to frost, are grown. Frost is more frequent at lower level because cold air sinks and warm air rises to the higher portions. Piedmont plains are often of great importance in irrigation. The mountain streams supply these areas with an abundance of underground water, which may be economically brought to the surface by pumping and then used for irrigation purposes.

Coastal plains.—For countless years, water, ice, wind, and gravity have deposited material of the land in the sea. These sediments have been constantly acted upon by waves and currents and spread out into level sea-bottom plains or continental-shelves. Their surface is gently sloping seaward; consisting of strata of gravel and sand near the coast, and mud farther out. Deposits of this kind border all continents, varying in width from a few feet to hundreds of miles. The position and extent of the sea-bottom plains are generally shown on maps in white or light blue, as continental fringes.

Due to the *uplift of the land* or the subsidence of the sea portions of such plains have become dry land and because they border the coast they are called coastal plains. They may be many miles wide, like the plains bordering the Atlantic and Gulf Coasts, or narrow strips of land as found along the mountainous coast of western South America. In general, the surface slopes toward the sea with such a little grade that the streams are sluggish and drainage conditions are poor.

These conditions (undoubtedly) *influenced the early settlers* of the United States. They avoided these lowlands, dotted with swamps and salt marshes, and occupied the more favorable seacoasts of New England. Agriculture has advanced slowly on the coastal plains because of their sandy soil which is not well adapted to farming. A considerable amount of fertilizer is necessary to add the essential plant food. As a result, the coastal-plain states *use more fertilizer* per acre than any of the interior states. A large part of the coastal plain of southeastern United States is still occupied by pine forests. Hence the lumber industry and naval stores supplies represent important resources of these coastal areas. However, the higher and less sandy regions of the coastal plains are favorable to agriculture, producing fruits, cotton, tobacco, peanuts, corn, and other products.

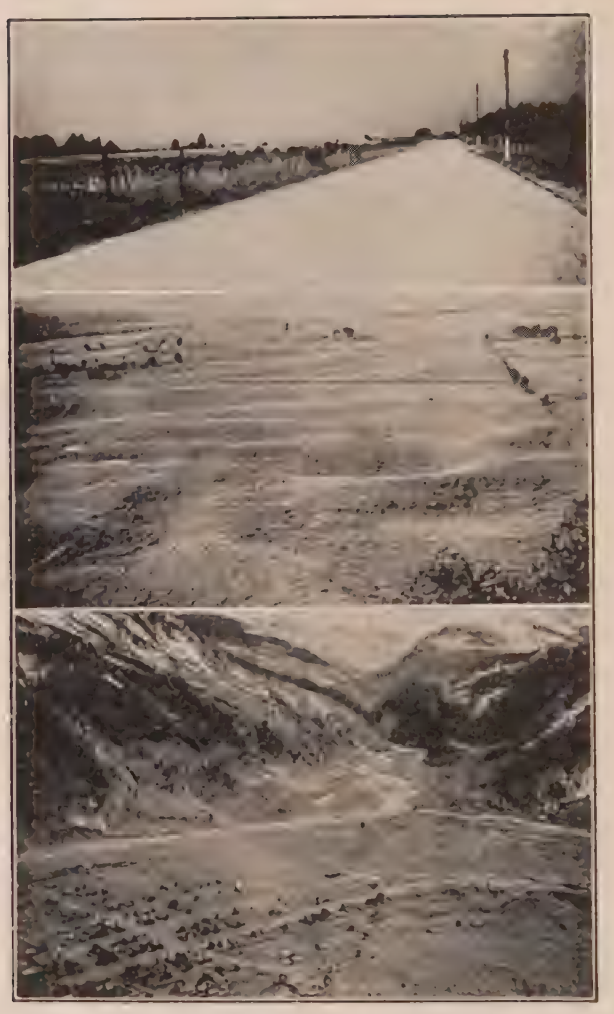


Fig. 69.—The Utilization of Plains.

Upper.—Coastal plain, Maryland. Corn, wheat, orchard, and level road. (Photo by U. S. Bureau of Agricultural Economics.)

Middle.—Glacial moraine plain, Wisconsin. The less rolling parts in cultivated farm crops, the rougher portions with many depressions used for pasture or timber. (Photo by Alden, U. S. Geol. Survey.)

Lower.—Town on an alluvial fan. (Photo by Ransome, U. S. Reclamation Service.)

Since the material of the coastal plain has been deposited more or less continuously for centuries, it is apparent that the same strata of sand, gravel, and clay has in the course of geological time hardened into rocks of various degrees of imperviousness and resistance. The more porous layers may contain a considerable amount of pure water. This value has been realized. As a result, there are hundreds of *Artesian wells* along the Atlantic and Gulf coasts, and many cities such as Atlantic City and Galveston obtain some of their drinking water from them.

The Fall line.—Where the coastal plain joins the older lands, such as the piedmont plateau of the Appalachian, there are thriving cities. The reason for this is that streams, flowing from the older land to the coastal plain, cut into the younger and less resistant material more effectively than in the older lands. Hence, waterfalls are frequently found interrupting the streams of the boundary between the old land and the plain forming what is called a " Fall line."

The influence of the Fall line on the location of settlements has been of utmost geographic importance. It represented in early days, the highest point to which boats could sail landward. Here it was necessary to carry the supplies above the falls to continue the passage upstream in smaller boats. Cities developed at these transshipment points which we recognize today as *Fall Line Cities,* such as Trenton, Philadelphia, Baltimore, Washington, Richmond, Raleigh, Columbia, and Augusta. At present the sites of these cities are benefited more by the water-power resources and strategic positions than as portage centers.

Æolian plains.—A uniform distribution of sand by wind may result in the formation of a level surface which is called an æolian plain. These plains are frequently found along the shore lines of lakes and seas, and in desert areas. Their regularity is generally broken by sand hills or dunes. An absence of vegetation is characteristic of æolian plains. Human activities found in such areas are few and in most cases are not permanent. (See Fig. 70.)

Great plains.—It has already been stated that plains may

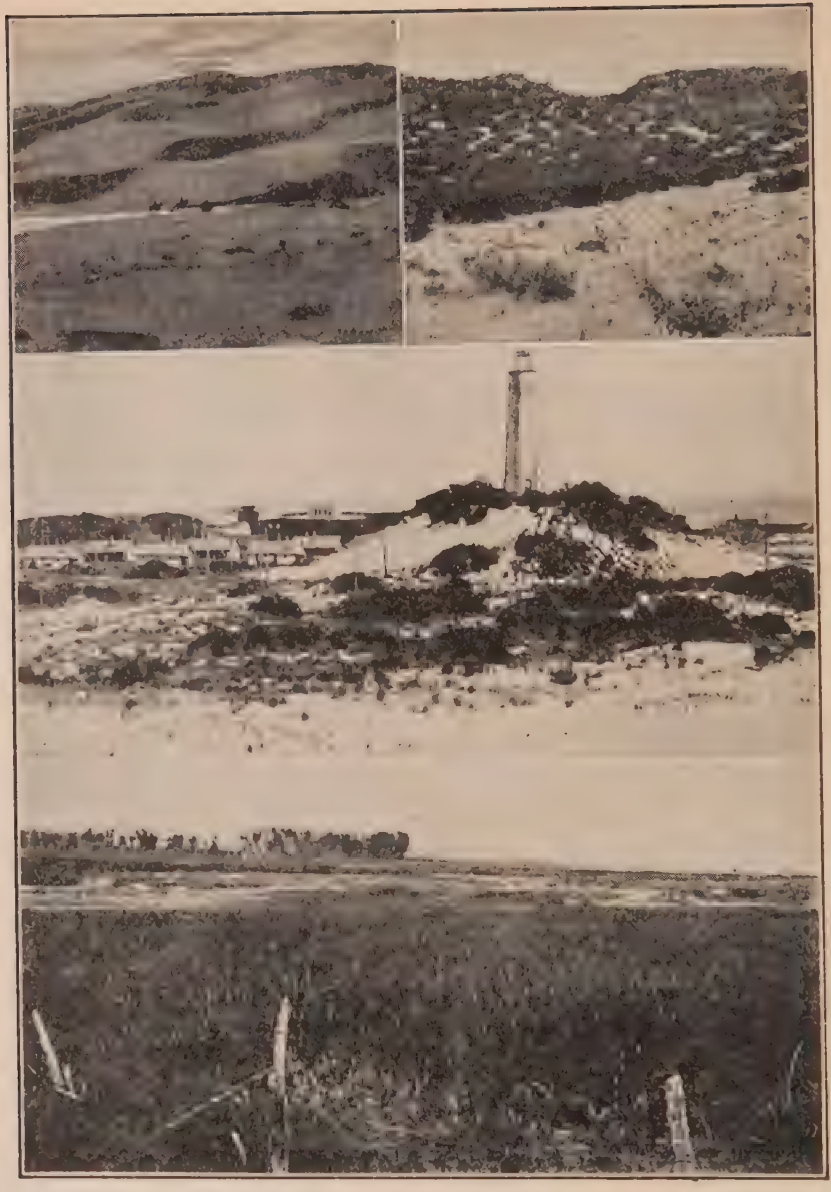


Fig. 70.—Sand Dunes and Marsh Land.

Upper left.—The Great Sand Dunes, San Isabel National Forest, Colorado.

Upper right.—Land reclaimed by beachgrass and wax myrtle, Province Lands, Mass. (Photos by U. S. Forest Service.)

Middle.—Lighthouses and sand dune topography at Cape Henry, Va. (Photo by Wentworth, U. S. Geological Survey.)

Lower.—Old-age stage of topography; plain subject to overflow. (Photo by U. S. Bureau of Agricultural Economics.)

be classified on different bases, such as climate, vegetation, location and origin. When the classification does not include the basis of origin, it should be kept in mind that the given plain may have a different origin in various parts of its area. For example, the Great Western and Central Plains of the United States consist of areas of lake plains, glacial plains, old alluvium plains, flood plains, and possibly other kinds of plains classified according to their origin. While the origin of plains is not the only key to their geographic importance, it is very likely to disclose the environmental details of plains.

Geography of Valleys.

Importance of valleys.—From time immemorial, valleys have played an important part in man's life. The *earliest concentration of peoples* took place along certain river valleys, such as the Nile, Tigris, Euphrates, Hwang Ho and Indus; also later along the Ganges and Yangtse-kiang. First, because these valleys, as well as others, contain our principal rivers, and rivers may be recognized as the natural avenues of transportation. Secondly, valleys offer access across divides, through plateaus and plains, or from land to sea. They are foremost in guiding the *lines of land communication.* Thirdly, valleys are important because of their *agricultural value.* The most fertile soils of the lands are found in valleys. The significance of the Ohio valley, Connecticut valley, and the Nile valley are worthy illustrations of the agricultural value of valleys. Valleys may also be sites of industrial importance, as regions of water power, accessible minerals, and forest resources. Man enjoys the mountains as lands of beauty but his work shop is primarily in the valleys, and on plains. Valleys offer protection from violent winds and rains which so frequently destroy life and the work of man on plains and mountains. But not all valleys are favorable for man's occupation, as the form of the valley may be of such a nature that it retards man's progress or activities.

Valley forms and human activities.—One of our foremost American geographers, Professor Davis, invented expressions to characterize the major forms of river valleys. He has ap-

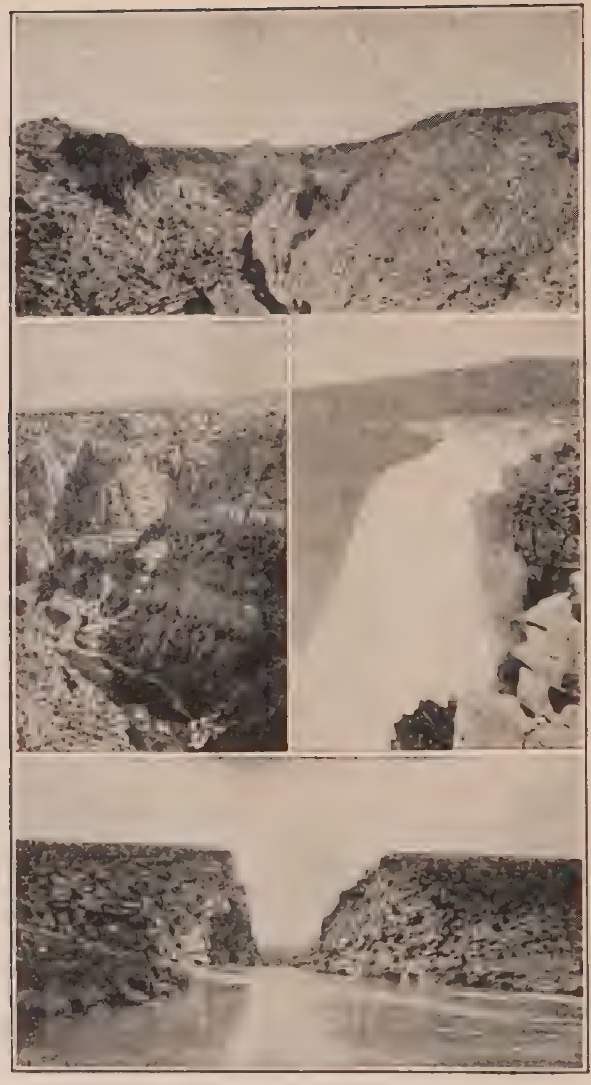


Fig. 71.—A Youthful Valley.

Upper.—Canyon of the North Platte River, Wyoming.

Middle.—(Right) Water flowing over Pathfinder Storage Dam (218 ft. high) into Platte Canyon (left). (Photos by B. F. Lemert.)

Lower.—Gap cut by the North Platte River through solid rock below the Pathfinder dam. This dam is one of the largest solid masonry dams in the world. The water is allowed to flow, as needed, down the canyon and beyond to the North Platte irrigation project 175 miles away. (Photo by Burchard, U. S. Geol. Survey.)

plied the terms, youth, maturity, and old age to the *stages in the development of river valleys.* In the *youthful stage,* a young river is deepening its valley, the valley sides are steep, the valley bottom is but little wider than the river channel, there are few tributaries, the divides are indefinite, and there may be waterfalls and lakes. At this time or stage the valley is called a young or youthful valley. The Niagara Gorge and Colorado Canyon are good examples of young valleys. Life in this type of valley is very sparse. There are few opportunities for agricultural practice. The waters are generally too swift for transportation and even perilous for crossing. Water power facilities, the storage of the water resources for human consumption, or irrigation in some nearby community or farming region may attract attention.

The term " youth " does not refer to years, but to the stage of development. A valley may be termed young even though in years it is older than a valley recognized as mature. The degree of stream erosion depends upon numerous circumstances, such as resistance of material over which the water flows, the amount of erosional tools carried by the water, the swiftness of the water, and the constancy of the flow.

Mature valleys.—In the course of time the river deepens, widens, and lengthens its course. Thus, it creates a valley with moderately sloping sides, a moderate grade, no lakes or waterfalls, well-defined divides, numerous tributaries, and flood plains in its lower portion. Such a valley is said to be in a *mature stage.* It represents the seat of favorable agriculture; its well-developed river system offers excellent transportation facilities; travel along or across its bottom is easy; access from one valley to another mature valley is not difficult; and progressive towns and cities occupy the slopes. The Ohio River valley is an excellent example of a mature river valley.

Old valleys.—As a valley grows older, the slopes become more gentle and the divides are reduced until the whole country is reduced almost to sea level. Extensive flood plains are forming which are generally poorly drained. A river of gentle grade and wide meanders flows through the level area. Thus, the river valley has reached the *old age stage.* The Connecti-

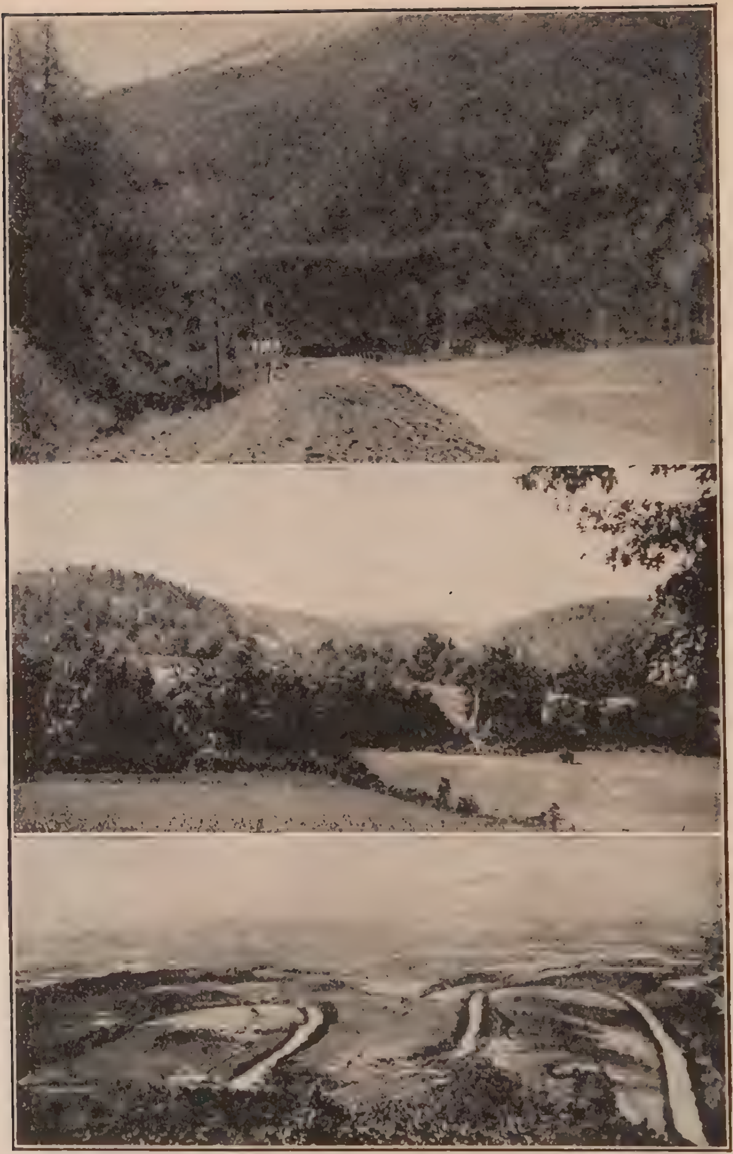


Fig. 72.—The Utilization of Valleys in Different Stages of Erosion.

Upper.—When a youthful stream widens its valley as it approaches the stage of maturity, man finds the extra space useful for his transportation routes. Lower end, Keystone Canyon, Valdez-Fairbanks Trail, Alaska. (Photo by Hunt, U. S. Geol. Survey.)

Middle.—In late maturity, farms occupy the valleys, and pastures the worn-down uplands. (Photo by Waldo Glock.)

Lower.—In early old age, the stream meanders through the flat or flood plain which it has cut below the level of the adjoining worn-down land, and fairly level farm land is plentiful. The Shenandoah Valley, Virginia.

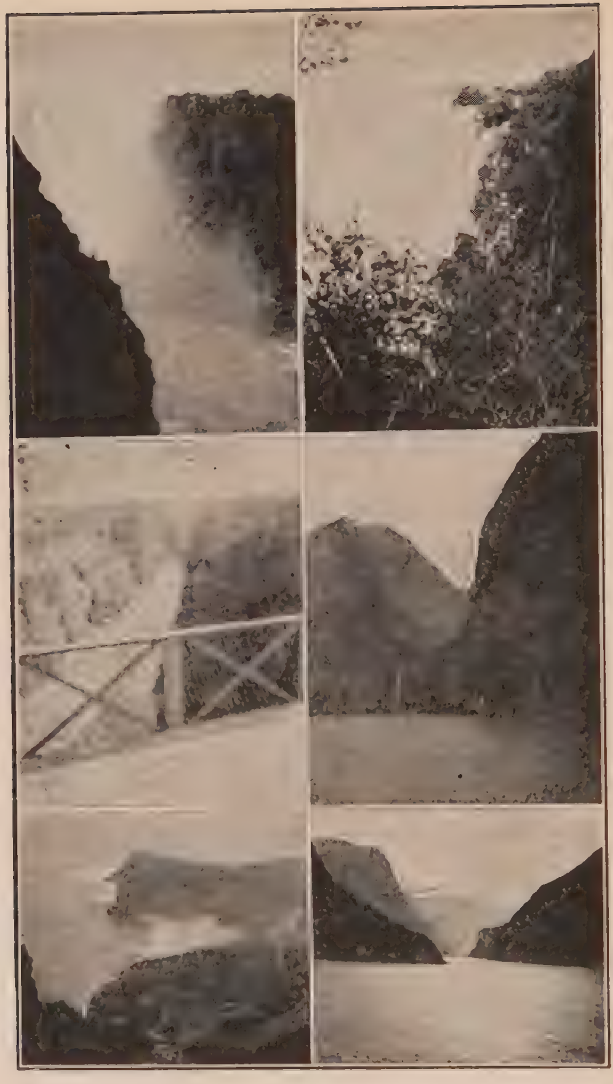
cut river valley at Northampton, Mass., and the lower Mississippi valley are illustrations of old river valleys.

Not all river valleys complete the *cycle of erosion* from youth, through maturity, and to old age. Uplift of the land or a lowering of the base level by the recession of the water into which the river flows may prevent lateral stream erosion. Thus the stream valley may remain in the youthful stage. It is also true that the entire course of any valley may not be in a given stage. All three stages may be represented from the river mouth to its source, due to the difference in the ages of the upper part and of the lower, and to the variability of effectiveness of erosion. Thus, the Mississippi River may be recognized as in the old age stage in its lower course, and youthful at its head waters. Like mature valleys, those in the old age stage are adapted to agriculture and dense settlements.

Again, not all valleys have been formed solely by stream erosion. *Faulting* or breaking of the earth's crust may be in part the origin of some valleys. Furthermore, *glaciers* have modified valleys in making them deeper, straighter, and more U-shaped and interrupted drainage by deposition or differential erosions, as a result of the formation of lakes. Hence, the study of valleys involves a careful consideration of terrestrial and extraterrestrial forces. Also, their human importance varies not only according to stage of development but also with other factors such as location, climate, soils, accessibility, and the like.

Islands.

Geographical peculiarities of islands.—The outstanding characteristics of islands are their limited area and isolated location. These geographical factors explain, in part, the tendency to overpopulate some islands. They account for the provincial character, the ethnical unity, the retardation of progress, and the survival of customs, so well recognized in many islands. The utilization of islands as sites for hospitals for contagious diseases, insane asylums, and prisons is largely



Photos by C. C. H.

Fig. 73.

Upper (Right).—A glimpse of Victoria Falls in Northern Rhodesia. These falls are twice as long and twice as high as Niagara Falls. The waters of the great Zambezi River here tumble into a gigantic fault in the rock, causing a heavy mist to rise for hundreds of feet above the falls. From this mighty cataract the waters surge through the rift or cleft seen above (Left) and then down through the gorge below (Middle Left.)

Middle (Right).—U-shaped hanging valley with waterfall in Milford Sound, one of the scenic fiords of South Island, New Zealand.

Lower (Right).—Entrance to Milford Sound, New Zealand.

(Left).—The Cape of Good Hope, South Africa.

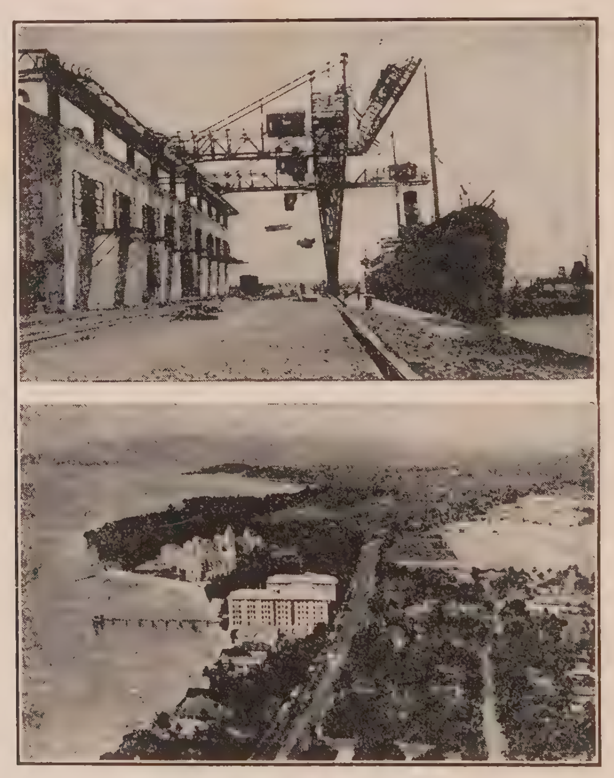
attributable to the size and isolation of insular lands. The effectiveness of these geographical influences of islands depends somewhat upon their position in respect to the mainland. On the basis of location, islands may be recognized as (1) Coastal Islands and (2) Oceanic Islands.

Coastal islands.—Coastal islands are found near the margins of the land, representing detached portions of the continents. The British Isles, the Channel Islands, and numerous groups of islands in the Mediterranean are a few illustrations of coastal islands. They are areas of *commercial and strategic importance.* In time of peace they have an advantage over their neighbors of the mainland in lying at the gateway of trade. Hongkong is an excellent example, as a guard to the trade of southern China.

During periods of war, coastal islands are favorable military sites to guard the ports of entry on the mainland. The islands at the entrance of the Panama Canal are heavily fortified for this purpose. It can be said that all coastal islands have some importance, whether it be as commercial centers, industrial and agricultural areas, or sites for social or military posts. While they may have the same trend of culture and development as that found on the mainland, they are very likely to maintain greater provinciality and independence, as they are less subject to invasions during military disputes as well as the fluctuating political and economic waves so frequently experienced on continents.

Many of our *harbors* have been formed by the presence of islands, acting as wind and wave barriers, and providing a peaceful bay well suited for harbor purposes, such as Boston Harbor. Then again, numerous islands off the coast may prove dangerous for navigation, thus destroying a safe approach to ports on the mainland. On the whole, however, coastal islands may be looked upon as lands of considerable geographical significance.

Oceanic islands.—At a distance from the coast are found islands in groups, such as the East Indies and West Indies; or as individual patches of land, such as the Spitzbergens, Iceland and Thomas Island. The *importance* of oceanic islands depends upon at least two factors: (1) their position in respect to trade routes and (2) their economic value. Islands in the paths of trade are favorable stepping stones, places for the replenishment of the necessary supplies, such as water, fuel and food. It is very likely that this importance will increase as oceanic aviation progresses.



Courtesy U. S. Dept. of Commerce.

Fig. 74.—Island Views.

Upper.—The commercial importance of coastal islands is indicated by this dock scene at Takao, Taiwan (Formosa). The modern steel hoist is American made, but operated by German electrical machinery.

Lower.—The famous Waikiki beach, with Honolulu and harbor in the background. The Moana Hotel in the foreground, and beyond that the $5,000,000 Royal Hawaiian Hotel, opened in 1927.

Even though oceanic islands are not on the Great Circle routes between continents, they may have *resources* of economic importance which attract commercial interest. This is true of Spitzbergen, which is distant from the North Atlantic trade route, but, nevertheless, it is visited by ships to bring back coal to northern Europe. In general, isolation of oceanic islands is far greater than that experienced by coastal islands. Iceland, for example, has been free from military invasion and social disturbance, and as a result has developed a high degree of culture.

Margins of the Land.

Sites of human activities.—The *gateways* to continents and oceans are found on the margins of the land. Without access to sea or land, a certain degree of confinement is experienced. Every nation looks toward the shore lines as areas indispensable to freedom and progress. As a result the largest city, as well as the leading financial and commercial center of each continent, with one exception, is located on the margin of the land: New York of North America, Buenos Aires of South America, London of Europe, Calcutta of Asia, and Sydney of Australia. The one exception is Cairo of Africa, which is located on the Nile.

There is not only the political and economic importance of shore lines but also the marked interest in their attractiveness as *places of recreation.* Yearly, tens of thousands of people enjoy the cool summer breezes, swimming, boating, and fishing of the seashore resorts.

Nature of coastal topography.—The nature of the coast line largely governs its social importance. Most broadly speaking, coast lines may be considered as being made up of promontories and bays. They correspond to the relief of the land. A cliff is generally a promontory or cape, and a valley a bay.

In places, the coast line is said to be straight or regular, a condition where the differences between the promontories and bays are not very great. In other cases, the coast line is recognized as broken or irregular, owing to marked indentations and promontories. The broken coast line is generally the more important as it offers favorable *harbor conditions* and access to the interior.

The major causes for the differences in the topography of coast lines can be attributed to (1) uplift of sea-bottom, (2) drowning of land, (3) erosion, (4) deposition, and (5) biological influences. These factors tend, in some cases, to make the coast lines. Such coasts generally have few good harbors line irregular.

Uplifted sea-bottom shore lines.—(1) *Coastal plains.* The uplift of sea-bottom plains produces low, flat, and regular coast lines. Such coasts generally have few good harbors and do not favor intensive human activities. Often the land in back of the coast is low, swampy, and unsuited for agriculture except in limited forms. The coasts of eastern central America, Yucatan, and southern United States illustrate the uplifted sea-bottom type of shore line.

(2) *Mountainous coasts.* Where mountains rise from the sea, as in the western Americas (Oregon to central Chile) a straight and *regular coast line* is produced. There are few indentations suitable for harbors; and the narrow belt of land that is level, and the mountain barriers of such coast lines have retarded commercial and industrial enterprises. In many places, along these straight mountainous coasts there is an abrupt descent from land to water, leaving practically no level land for city sites. Only where a valley enters the sea, has man made any progress.

But not all mountainous coasts are straight. In fact, the tendency is for mountain uplift from the sea to make *irregular coasts* rather than straight coast lines. The irregularity of coasts may be due to various causes, such as (a) the formation of a chain of islands along the coast resulting from mountains, such as the West Indies, Philippines, Japanese islands, (b) the extension of land into the sea in the form of peninsulas as a result of mountain building, such as Alaska, Italy, Greece, and the Malay Peninsula, (c) the formation of gulfs and seas, due to the sinking of the crust between mountains, as in the case of the Gulf of California, Bay of San Francisco, and the Mediterranean, China Sea, Red Sea, Japan Sea, Gulf of Mexico.

The irregular mountainous coasts are more favorable for occupation than the straight mountainous coasts. Communication is generally difficult over land and frequently necessitates access by sea. But the numerous harbors and extensive indentations favor navigation. This is one reason why navigation and seafaring interests in early times centered in the Mediterranean sea, the coast of Norway, and the British Isles. In many cases the only means of access at these early periods to parts of these lands was by boats.

Coasts of drowned lands.—The submergence of the land makes the coast line irregular because the valleys form bays and the divides or ridges are transformed into promontories or islands. Such bays as the Boston harbor, San Francisco harbor, the lower Hudson and the broken coast of Maine are a few worthy illustrations. In places where the water does not completely cover the land, islands may form, as the British Islands, Newfoundland, and thousands of others along the submerged northern coasts of North America and Europe.

The glaciated coasts of Scandinavia, Canada, southern Chile, and southern New Zealand, known as *fiord coasts,* are in part due to the sinking of the coast. These fiord valleys were first cut by streams, modified by glacial erosion, and then submerged, forming narrow straight indentations. (See Fig. 73.)

It is true in the discussion of all coasts, that the nature of the land, the type of rock, rate of erosion and deposition, and the like are responsible for many of the differences in coast line. For example, the drowned coast of New York is different from that of Maine because of a difference in the nature of land and type of erosion.

Drowned coasts are most *favorable for settlement* and progress because of the numerous harbors and gateways to the interior along its drowned river valleys.

Coastal erosion and deposition.—The margins of the land are constantly subjected to the erosional forces of wind, water, and ice and modified by the deposition of rock waste, produced by coastal denudation or brought down by rivers in the form of alluvium. The ultimate effect of these actions is to straighten, or make more regular, the coast line. The head-lands are worn back and the bays are filled with sediment. Cliffs, rock terraces, sea caves, chasms, stacks, and sea arches may develop in the course of erosion, their nature depending upon the character of the rock and type or degree of erosion.

The material carried about by the waves and currents may be deposited in the form of offshore bars or barriers, hooks, spits and cusps. Sediment deposited in estuaries or bays behind sand bars may completely fill them. In time, the deposits of sediment in the lagoons may reach to the level of high tide, forming a salt marsh-plain, such as those of the Atlantic seaboard of the United States. Salt-water plants may flourish in these marshes, adding their remains from time to time to the filling. Where dikes have been built, salt marshes have been reclaimed for fertile agricultural land, such as the polder lands of Netherlands and the lowland of England. In time, the extensive marshes near New York and Boston may be protected from the tidal water, drained, and reclaimed as valuable farming land. In warm tropical countries, the salt marshes are almost impenetrable jungles of mangrove swamps.

Coral influences on coastal topography.—On the coasts of some tropical lands, animal life, especially coral, has greatly modified the coastal topography. The remains of these animals are so abundant in some places, that the entire shore is made up of their remains. They may build circular reefs around submerged islands, known as *atolls,* and others, off shore somewhat, called *barrier reefs.* There are numerous *fringing coral reefs* close along the shore of islands, as in the Caribbean sea. The most extensive barrier reef is found along the northeastern coast of Australia at a distance of 20 to 50 miles off shore. It is called the *Great Barrier Reef.* Behind it is a navigable lagoon of protected water. The Bermudas, whose base beneath the sea is a volcanic cone, are surrounded by a fringe of coral reef.

Land Utilization.

Major types of land utilization.—Having discussed the relation between man and (1) the foundational aspect of land, (2) the position or distribution of land, (3) the size or area of land, (4) the shape of land, (5) the accessibility or remoteness of land, (6) the surface features of land, (7) the continuity of land, and (8) the coasts or margins of land, our attention is now directed to the geographic importance of the resources of land. The principal forms or types of land utilization based upon the nature of the resources are (1) Utilization of land for forests, (2) Utilization of land for agriculture, (3) Utilization of land for civic or city purposes, and (4) Utilization of land for mining purposes. These types of land utilization are characterized in the next four chapters.

CHAPTER X

THE UTILIZATION OF FOREST LAND

The Forests of the United States.

Human use a geographic factor.—Since geography is a study of reciprocal relationships, it should be kept in mind that it is not merely a study of the influences exerted on man and his affairs by the environment, but also, an account of the way he adjusts himself and his activities to the environment; of the ways he utilizes an element of the environment in the gratification of his wants. Dr. P. M. Roxby, Professor of Geography at the University of Liverpool, in speaking of the adjustment of human groups to their physical environment, says: "The term adjustment includes not only the control which the environment exerts on their activities but the use which they make or can make of it." This aspect of the science is seen no more clearly perhaps in the case of any other environmental factor than in that of land, the varying phases of the utilization of which constitute so essential a part of all geography.

Land utilization in American geography.—American geographers, perhaps more than those of any other country, have emphasized the significance of land utilization as a fundamental subject in geographical study. This has come about, doubtless, largely owing to the relatively short time since the country was first settled by Europeans, many of whom were drawn to our shores by the abundance of free land or cheap land that was so long available to all who had the courage and strength to come over and undertake its settlement and cultivation. The settlement, starting on the Atlantic coast, gradually spread westward until the frontier reached the Pacific. This westward movement of the frontier made possible, at most times, a sort of bird's-eye view of all the stages of utilization of land, from the growth of towns and ports in the east, through the stages of logging and farming farther inland, to the grazing or mining or hunting stages of the frontier.

Forests cleared for farms.—Originally most of the country east of the Mississippi River was covered by a dense forest which constituted a distinct obstacle to the utilization of the land for farming. Not much progress in agriculture could be made until the forest was cleared off, and even after clearing, the stumps and roots made cultivation difficult for years afterward. The trees and logs were looked upon by the farmers as handicaps and their first concern was to get rid of them as fast as possible. Trees that had taken generations to grow were felled, and magnificent logs piled up and burned just as was the brush. Log-rollings were social events in the pioneer days of the eastern forest region.

After the farming frontier reached the Mississippi its westward movement was much faster owing to the lack of timber on the western prairies and plains. It was largely the lure of the land, its utilization for farm, forest, ranch or mine, that speeded up the western movement. Naturally, then, land utilization has come to occupy a prominent place in American geography.

Principally, in order that the land might be utilized for farming, about a fifth of the original forests in the United States, or about 150,000,000 acres of timber, were felled by the year 1880. By that time big lumber companies, too, had got their systematic timber removal under such headway as about to equal the demand for new farm land. After that date, timber in this country was cut, not to provide more land for agriculture, but chiefly to supply the increasing lumber demand for our rapidly growing industries. As a matter of fact, since then our forests have been removed much faster than the land could be utilized for agricultural purposes. The ruthless destruction of our timber during the early period may have been economically justified on the ground that it made possible the utilization of the land for a higher purpose, but unfortunately the practice continued for some generations longer than was economically desirable or socially justifiable from the point of view either of timber supply or of proper land utilization.

Three hundred years of action in accordance with a false psychology that our timber supplies were inexhaustible and that all the land we occupied was destined ultimately for agriculture, has not only left us with thousands of acres of cut-over land, much of which is entirely or relatively unfit for farming, but has so fixed in the public mind the habit of indifference to forest destruction that it is hard to arouse people to a sense of its danger even in the face of a threatened timber famine. The notion has long persisted in our Lake States and Southern States, for example, that all forest land is potential agricultural land and can be sold by the lumberman to the farmer at $10 an acre or more as soon as the virgin timber is removed. At last, however, this phantasy seems to be dead. Some large timber companies, that were the most persevering and spent the most money in the effort to colonize their stump lands, have at last realized the futility of such a policy and are now looking to forestry as a hope.

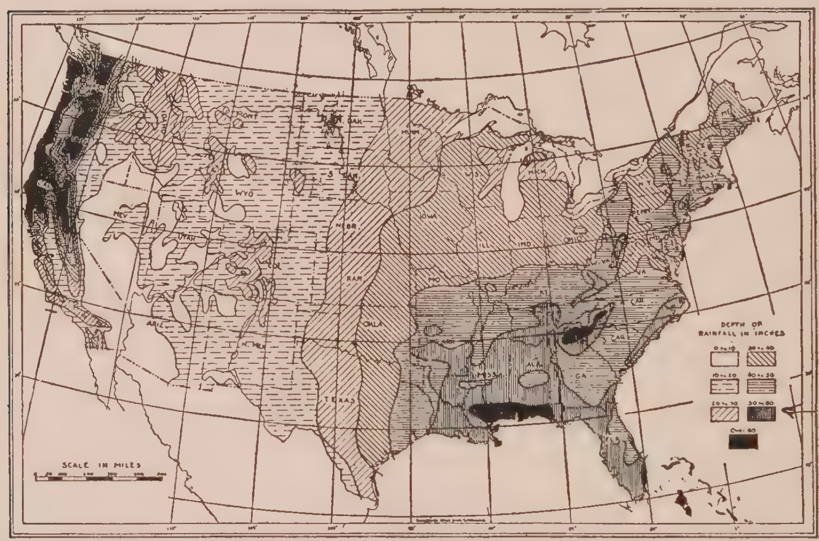
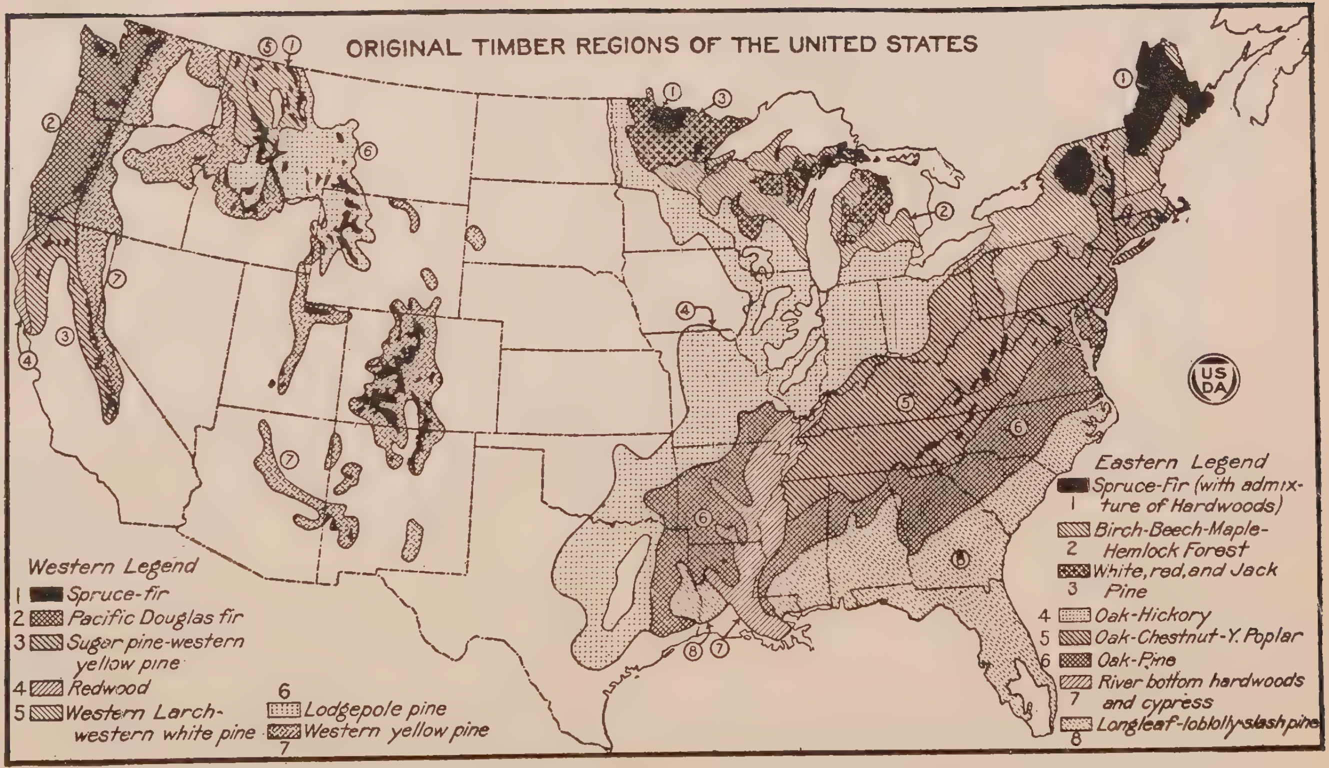


Fig 75.—Rainfall Map of the United States.

Extent and distribution of our forests.—Of the 1,903,000,000 acres of land in the United States, more than 822,000,000 acres were originally in forests. These existed chiefly in three broad belts extending, in general, north and south. The first extended along the Atlantic coast from Maine to Florida, reaching inland beyond the Mississippi River and fringing out along the streams of the Central Prairies and the Great Plains. A second belt, more or less interrupted in area, extended along the Rocky Mountains and outlying ranges from Idaho and Montana on the north to Arizona and New Mexico on the south. Finally, the third belt occupied the Pacific Coast region of Washington, Oregon, and northern California extending eastward across the Cascade Mountains and from there southward including the Sierra Nevada mountains well toward southern California. The first belt consisted of three regions: (1) the Northeastern forest, predominantly conifers of which white pine and red spruce were the most important, the northern parts of New England, New York and the Lake States of Michigan, Wisconsin and Minnesota, and reached southward along the Appalachian Mountains; (2) the Central forest (characterized by hardwoods, such as oak, hickory, walnut, elm, ash, and yellow poplar), extended from southern New England, west to eastern Iowa, and reached southward to the southern coastal plain; (3) and the Southern forest (predominantly yellow pine) occupied the Atlantic and Gulf coastal plains from New Jersey to Texas. The trees of the Rocky Mountain forest are closely related to altitude. Junipers, Pinon pines, and scrub oaks characterize the lower elevations. Western yellow pine is typical of the next higher belt. Higher altitudes contain Douglas fir and lodgepole pine. And the highest belt of commercial forest includes spruce, alpine fir, and minor species.

/ The heaviest stand and the largest timber in North America, if not in the world, are found in the Pacific forests/ Here are some hardwoods of economic importance; but these forests are mainly conifers; such as, the redwoods of giant size and great age in the coast ranges of northern California, the great tall Douglas firs of western Oregon and Washington (now the center of our largest timber industry), and the western yellow pine and larch, firs, etc., east of the summit of the Cascades and on the Sierra Nevada mountains of California.


ORIGINAL TIMBER REGIONS OF THE UNITED STATES
Western Legend
1 ■ Spruce-fir
2 ▩ Pacific Douglas fir
3 ▨ Sugar pine-western yellow pine
4 ▨ Redwood
5 ▨ Western Larch-western white pine
6 ▦ Lodgepole pine
7 ▩ Western yellow pine
Eastern Legend
1 ■ Spruce-Fir (with admixture of Hardwoods)
2 ▨ Birch-Beech-Maple-Hemlock Forest
3 ▩ White, red, and Jack Pine
4 ▦ Oak-Hickory
5 ▨ Oak-Chestnut-Y. Poplar
6 ▩ Oak-Pine
7 ▨ River bottom hardwoods and cypress
8 ▦ Longleaf-loblolly-slash pine
US DA
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Map by U. S. Department of Agriculture.

Fig. 76.—The Original Forest Regions of the United States.

The original acreage of these five regions as well as their present extent may be seen from the table on page 277; while the chief kinds of timber and the distribution of each are shown on the map in Fig. 76. The geographic relations of this map to that of soils should be compared from Fig. 85 in the next chapter.

Timber mining.—Only a tenth of the northern forest remains uncut. In the central forest about a twentieth of the virgin timber remains. Of the southern forest probably an eighth of the virgin timber is left, while over half of the acreage of virgin timber still stands in the Rocky mountain region and about a half of that of the Pacific coast forest. While this would indicate that some 65% of the acreage of the original forest still stands, the fact remains that the best timber is usually cut first and this together with damages from fire, etc., make it certain that the United States does not now have over 50% left of the merchantable saw timber it originally possessed.

The standing timber on the original vast area of 822,000,000 acres was chiefly of high-grade, and estimated to contain more than 5200 billion board feet. Just as many of our agricultural lands have become exhausted through the soil mining method of careless and reckless farming, so exploitative timber mining with its accompanying forest fires has reduced this 5200 billion board feet to some 1600 billion feet of virgin timber and perhaps another 600 billion feet of culled and second growth stands. Of our remaining virgin timber only one-fourth is east of the Great Plains, where the population and demand for lumber are greatest. Over one-half of our remaining saw timber is in Washington, Oregon, and California, over 2000 miles from the centers of population and manufacturing of the country. So far apart are our lumber-producing and lumber-consuming centers that each year a freight bill of $250,000,000 adds its load to the cost of lumber, already high on account of increasing demand and decreasing supply. This depletion of timber supplies affects not only the quantity and quality of our forest resources, but has decreased the forested land from 822,000,000 acres, nearly half the area of the United

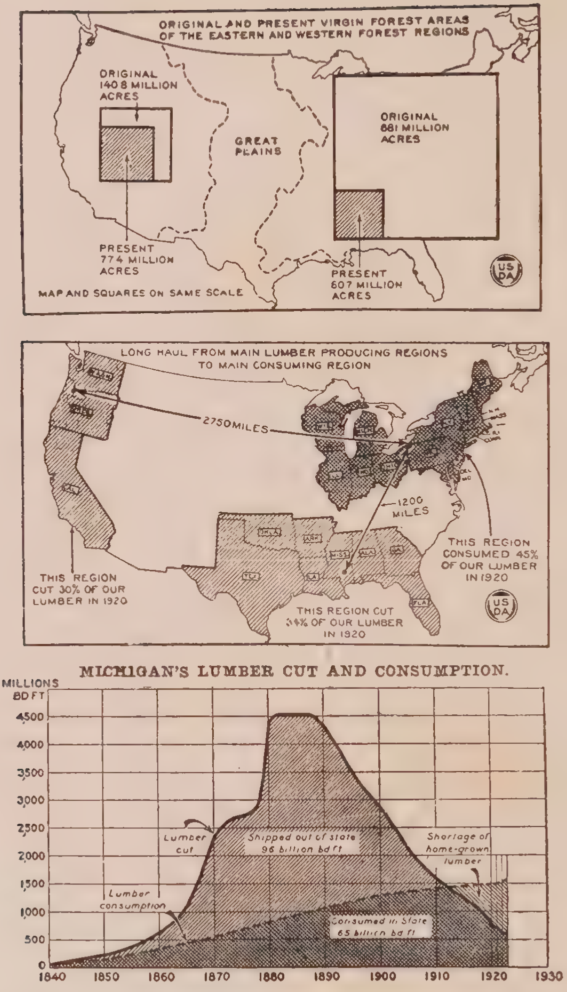
ORIGINAL AND PRESENT VIRGIN FOREST AREAS OF THE EASTERN AND WESTERN FOREST REGIONS
ORIGINAL 140.8 MILLION ACRES
GREAT PLAINS
ORIGINAL 881 MILLION ACRES
PRESENT 77.4 MILLION ACRES
PRESENT 60.7 MILLION ACRES
MAP AND SQUARES ON SAME SCALE
US DA
LONG HAUL FROM MAIN LUMBER PRODUCING REGIONS TO MAIN CONSUMING REGION
2750 MILES
1200 MILES
THIS REGION CONSUMED 45% OF OUR LUMBER IN 1920
THIS REGION CUT 30% OF OUR LUMBER IN 1920
THIS REGION CUT 34% OF OUR LUMBER IN 1920
ARK
MISS
ALA
GA
LA
FLA
US DA
MICHIGAN'S LUMBER CUT AND CONSUMPTION.
MILLIONS BD FT
4500
4000
3500
3000
2500
2000
1500
1000
500
0
1840
1850
1860
1870
1880
1890
1900
1910
1920
1930
Lumber cut
Lumber consumption
Shipped out of state 96 billion bd ft
Consumed in State 65 billion bd ft
Shortage of home-grown lumber

Fig. 77.—Some Effects of Forest Removal in the United States.

Upper.—Only a small part remains of the originally great forest of the East, and only about half of the virgin forest of the West.

Middle.—As the timber-cutting shifts westward, the average rail haul and freight cost increase.

Lower.—After exporting 96 billion board feet of lumber from 1850 to 1912, Michigan now produces less than she needs.

States, to about 138,000,000 acres of virgin forest, 250,000,000 acres more of rather inferior-culled and second-growth land and 81,000,000 acres of unproductive land. The distribution of these areas between the East and the West is shown in Fig. 77. These cut-over lands have not been used to any extent for agriculture in recent years. For instance, Michigan with 15,500,000 acres of cut-over land added only 93,000 acres to her improved farm land between 1910 and 1920.

So the destruction of our forests and our inability to turn the cut-over lands into farms have led to two great problems before the American people to-day. How are we to provide for our timber needs in the future? And how are we to utilize the cut-over and burned-over forest lands?

The Problem of Land Utilization.

Land as extension.—One of the fundamental geographic properties of land is that of solidity or extension, that is, it provides support or standing room for man and his works. Not all of his industries, however, require the same amount of space. Much more space is needed to support a given population by hunting than by grazing, and the grazing industry requires more land than agriculture. In general, it may be said that the industries which appropriate or increase the products of the soil, as hunting, grazing, logging, farming, and forestry, all require a great deal of room as compared to mining or the secondary industries like manufacturing and wholesaling or retailing. People engaged in industries which collect or develop the products of the soil, therefore, are necessarily spread over wide areas in proportion to their population. Having, thus, to live in scattered homes or in small villages far apart, they tend to be called rural; that is, field or open-space people, like their industries. On the other hand, indoor industries require so little space relatively that they can generally be walled in and roofed over. These differences, in space requirements, between indoor and outdoor industries, together with their direct and indirect consequences on the people engaged in each, often tend to make it hard for rural and urban people to understand one another, and to realize that in the long run the welfare of the one group depends a great deal on that of the other.

Both indoor and outdoor industries, from one point of view, are stages in economizing space; different methods of land utilization. By economizing space, in agriculture for example, is meant endeavoring to get as large a product per acre as possible. But space is only one of the properties of land; soil fertility is another. So, excessive economy of space may mean a sacrifice of plant food, an exhaustion of soil fertility, which is sometimes called mining the soil. Moreover, agricultural production always involves a combination of land with labor and other capital. So, excessive economizing of land may mean a waste of labor and capital. It is possible to try to raise so much per acre that the product per man may be reduced. This problem is largely one of the ratio of land to population. Thus, Belgium with a population density of 675 to the square mile produces over twice as many bushels of wheat per acre as the United States where the density of population is only 40, but the output of wheat per man in the United States is far more than double that in Belgium.

The law of diminishing returns.—This conflict between the economy of land and the economy of labor gives rise to what is commonly known as the law of diminishing returns from land. This law is simply a statement of the fact that *after a certain amount of labor* (together with the appropriate capital in the way of seed, machinery, and fertilizer) has been put into the cultivation of a given crop on a given piece of land, any *further applications* of labor (and capital) *do not produce proportional returns.* That is, they may increase the total crop a little, but not in proportion to the increase in labor.

Now, as labor and capital cost money, it results that such intensive cultivation of land in agriculture, if carried far beyond the point of diminishing returns, will ultimately result in smaller and smaller profits until finally the returns are only equal to the cost. Then profit has disappeared, and if the increase of labor and capital is continued further a loss occurs. Land whose product just repays the expense of cultivation is known as *marginal land.* The margin may be either *intensive,* as when more labor and capital are applied to the same piece of land; or *extensive,* when additional land of poorer quality is utilized. Lands below the margin will not repay cultivation under the given conditions, but if conditions improve sufficiently, such as an increase in the price of the product or a discovery of cheaper fertilizer, then some of this sub-marginal land may again be cultivated with profit. But in that case they would again be above the margin. Such developments illustrate again the working of the principle of change in geographic relationships, the effect of change either in the human or in the environmental factor. The tendency to diminishing returns must be understood with reference to a given stage in agricultural science. It applies also to the utilization of other resources, being cited here in connection with agriculture merely because of its importance in land utilization.

Sub-marginal agricultural land may pay in forests.—In view of the drift of our population to the cities, the increased use of agricultural machinery on the farm, and the advances in knowledge of soil science and farm practice, authorities on agriculture in this country are coming to believe that the tendency of American farming in the future will be that of more intensive utilization of the better lands, leaving the marginal and sub-marginal lands to other uses. Much of this land that thus remains out of, or passes out of cultivation, because, if farmed, margins of profit would be too small or uncertain on account of poor soil, rugged topography, unfavorable climate, or disadvantageous location, might well be devoted to the growth of forests.

In order for forestry to be an economic success on such lands, it ought to produce a greater value, at a lower cost, raising timber, than some other crop. Timber is of such slow growth that the yearly product is small, hence the cost should be small. So, cheap land is essential for utilization in forestry. Land which would otherwise go to waste entirely, might well raise timber, if possible, for it obviously would be better to have it yield even a small product each year than to yield nothing at all.

Land available for forests in the United States.—The character of the vegetation of a region is closely related to the soil. Therefore it may be assumed that practically all of the desert and semi-arid soils and most of the sub-humid or prairie soils will not be utilized for forests. Of course the entire area, which was once a forest, is physically capable of producing forests again, but socially it is impossible that it should do so, because much of that acreage must be put to other uses. Agriculture now uses some 503,000,000 acres and will undoubtedly need more as our population grows. Cities, parks, roads and railways also demand increasing space. Thus there are social limits to forest land utilization. The following table shows the area now classed as forest land in the United States to include a total of nearly 470 million acres. But only about 138 million acres of that are covered with virgin timber. Over 81 million acres are now non-restocking as far as forest growth is concerned. This is wasteland, unproductive, hence it should be reforested. The remaining 251 million acres of cut-over or burned-over forest land consist of 113,800,000 acres of second growth of saw timber size and 136,400,000 acres of second growth of cordwood size.[1] These great areas if properly taken care of can be made to yield a paying and permanent income in forest crops.

The question is, *will our growing population require that much of this forest land be devoted to other purposes?* During the 19th century our population increased from 5,308,483 to 75,994,575. At the present rate of increase it would double in 50 years, but the rate of increase is on the decline. Fair estimates indicate, however, that by 1950 our population may be 150 million. Dr. L. C. Gray of the U. S. Bureau of Agricultural Economics figures that this would require an increase in our present improved farm area of not more than 58 million acres, made up of perhaps 35 million acres of crop lands and 23 million acres of humid pasture land. It does not necessarily follow, however, that this increase, in farm land used, must all come from forest land. Farming, being a higher use of land than forestry, will, of course, have the first claim on the most productive lands. It may be stated, however, that forest soils are not always the most productive. Nevertheless, many of the forests now growing on fertile bottom and valley land, for example, will be cleared off and farm crops take their place. These areas lost to forests, however, are likely to be balanced more or less by many of the rougher and poorer farm lands, sub-marginal for one reason or another, being allowed to grow up again in forests, because the farming on them returns relatively small income in proportion to the labor and capital necessary to operate them as farms.

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[1] Timber: Mine or Crop? p. 91.

THE DISTRIBUTION AND EXTENT OF THE ORIGINAL AND PRESENT FOREST AREAS OF THE UNITED STATES[2]

Forest Region	Original Forest	Present Forest			
		Total Area	*Virgin Timber*	*Cut-over and Burned-over*	
				Now in Second Growth & Culled Timber	*Now Waste Land*
	(acres)	(acres)	(acres)	(acres)	(acres)
Northeastern	150,000,000	105,000,000	15,000,000	60,000,000	30,000,000
Central	281,000,000	109,000,000	14,000,000	90,000,000	5,000,000
Southern	250,000,000	135,000,000	31,000,000	70,000,000	34,000,000
Rocky Mt.	65,000,000	61,000,000	38,000,000	18,000,000	5,000,000
Pacific Coast	76,000,000	59,000,000	39,000,000	13,000,000	7,000,000
	822,000,000	469,000,000	137,000,000	251,000,000	81,000,000

It is likely that the *additional land needed for agriculture* in the United States during the next generation will largely come from irrigation in dry regions, from reclamation of wet lands, and from the utilization as crop and pasture land of much of the land already included in farms but now classed as unimproved land. Of the 879 million acres already in farms, in the United States, in 1919, for example, only 478 million acres were actually under cultivation. That most of the additional crop land needed by the middle of the century will come from the sources suggested above is made probable by the fact that most of the land now in forests, especially that in the mountainous and hilly regions, would really be sub-marginal as agricultural land and could be made to produce farm crops only at a high cost. Whether such sub-marginal farm land will be devoted to agriculture will depend in part on the relative need for food or timber and the relative costs of producing each. Undoubtedly some forest land will be changed to farm land, and some farm land will revert to forest use. Hence, under present conditions our present area of 470 million acres of forest land may be considered a " fairly close approximation of profitable use for idle lands."

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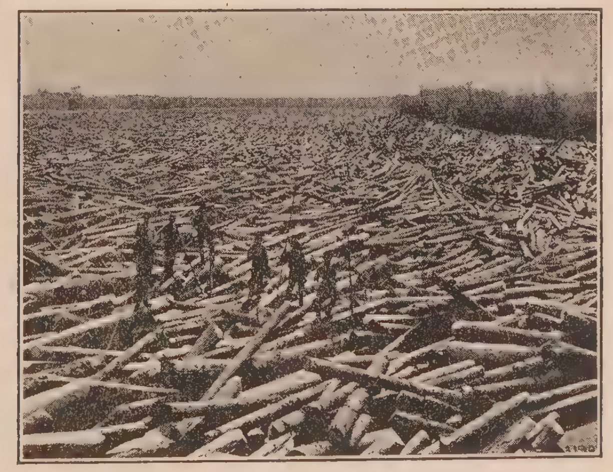
[2] Compiled from Zon and Sparhawk, "Forest Resources of the World," Vol. 11, p. 521 to 526.

The problem of idle forest land.—The fact that 251 million acres of our forest lands are now producing much less than they should, that over 81 million acres more are waste and unproductive, and that the area of this idle or largely idle land is increasing four or five million acres a year or some 16,000 acres a day, due to timber cutting and forest fires, has resulted in a difficult problem of land utilization for the future. The *menace* from these great unused land resources of the United States arises from several sources. First, there is the danger to the lumber industry. As the forests disappear and saw mills are dismantled, laborers are thrown out of work, population falls off, and villages are deserted. Second, transportation facilities are seriously affected by idle forest lands. Freight is no longer available to the railroads of such regions with the timber gone. The diminishing population cuts down passenger traffic and finally the railroad is torn up or abandoned. Taxable property declining in the cut-over district, adjoining areas are then burdened with heavier taxes to provide revenue for the township, county, or state. The farm lands usually scattered through forest regions, or near them, are handicapped by such effects of timber depletion and the resulting non-use of the forest lands. Increased tax rates, poor transportation facilities, and the lack of the markets formerly furnished by the lumber industry result in decreased value of farm products and farm lands. The farm lands of the community, once profitable, now become sub-marginal agricultural land. Many of the farms are abandoned. The towns and cities feel the same effects, and depopulation of whole communities results.

Permanent prosperity results from continuous use of forest lands.—On the other hand, if these cut-over lands are reforested and made productive, the taxable wealth of the community is increased. Schools and roads are improved. The growing supply of timber gives permanent employment to labor, provides traffic for the railroads, furnishes raw material for wood-using industries. This means better markets for the farms, more business for the towns, more inducements for individual home ownership, and permanent schools, colleges, and churches. In a word, the efficient use of forest lands contributes to better citizenship and to the advancement of civic welfare.

The Problem of Our Future Timber Supplies.

The development of lumbering in the United States.—While previous to 1880 the American forests were cut largely to provide agricultural lands, yet even in the colonial days lumbering was developed along the Atlantic seaboard as a local industry. Rivers provided transportation for logs, and water



Courtesy U. S. Forest Service.

Fig. 78.—A Log Drive, Glens Falls, New York.

power for small saw mills. When canals were constructed, local markets for timber products were extended, but when the railroads developed, the lumber industry was revolutionized. Long-distance transportation then became possible and large-scale production became both possible and profitable.

By the time the wave of timber destruction reached its height in the Lake States, after 1880, the *concentration of ownership* of forest lands in the hands of corporations and "lumber kings" became characteristic of the lumber industry. In 1910, the United States Bureau of Corporations reported that one-half of the privately owned timber in the United States was held by about 250 large owners, the ownership of the rest being very widely distributed. Conditions of concentration have not changed much since then. At present about 79% of the timber-growing land of the country is in the hands of private owners.

The westward migration of our lumber production.—Before 1850 the lumber production of the United States was chiefly in New England and New York, the latter state being the largest producer in the country in 1850. Now, New York produces only a tenth of her own needs for wood. By 1860 Pennsylvania became the leading lumber state; now that whole state doesn't cut enough to supply the Pittsburgh district, alone. Before 1900 the Lake States of Michigan, Wisconsin, and Minnesota had risen to first place, passed their peak in production, and started to decline. The fine pine forests of these states originally estimated at 350 billion feet are now reduced to less than 8 billion feet. Between 1850 and 1910, Michigan alone exported about 100 billion board feet of lumber. In 1920, she imported a billion feet and these imports came from such distances that the freight bill alone cost the people of that state $15,000,000. The increase and subsequent decline of Michigan's lumber cut, until her once-called "inexhaustible" forests *no longer cut enough to provide for her increasing lumber consumption,* are shown in the diagram (Fig. 77).

These Michigan timber conditions are *typical of the other Lake States.* In fact, the whole region, now densely populated, from New England west to Minnesota, was formerly a lumber-exporting section and still contains immense areas of forest land. Yet this region is now increasingly dependent on timber and its products produced elsewhere, much of it having to be shipped the width of the continent. Most of the building and structural timber used in the eastern and central states since 1900, was grown in the pine forests of the south, whose lumber cut increased from a quarter of the country's total, in 1900, to nearly a half at the opening of the Great War in 1914. But the lumber-cut of these great southern pine forests is already beginning to decline, and, before long, will hardly more than supply the growing needs of the south itself. The migration of the timber destruction is passing to the Pacific Coast states, which cut 19.3% of the United States total in 1914 as compared with the 47.7% from the south, but which in 1926 cut 38.4% as compared with 42.1% from the southern states. This shifting of lumber from New England to the Pacific Coast is shown in the following table:

PER CENT OF TOTAL UNITED STATES LUMBER CUT BY REGIONS[3]
1850 to 1926

Year	North-eastern States	Lake States	Southern States	Pacific States
1850	54.5	6.4	13.8	3.9
1860	36.2	13.6	16.5	6.2
1870	36.8	24.4	9.4	3.6
1880	24.8	33.4	11.9	3.5
1890	18.4	36.3	15.9	7.3
1900	16.0	27.4	25.2	9.6
1914	9.0	10.5	47.7	19.3
1926	3.8	5.6	42.1	38.4

Our remaining timber far from its market.—One great difficulty, arising from this depletion of the eastern forests, is that those were the forests most available to the great bulk of our population, agriculture, and manufactures. The timber left is not in the right place. This means longer hauls and higher costs for lumber and all its products. The great and growing demand for timber for our farms and industries must now be supplied largely by our last great timber resources in the far northwest, some 2500 miles from the centers of consumption. This may be seen from the map.

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[3] *Some Public and Economic aspects of the Lumber Industry*, W. B. Greeley. U. S. Dept. of Agr., office of the Sec'y, Report No. 114, 1917, p. 6. *U. S. Commerce Year Book*, 1928, Vol. 1., p. 341.

Our needs for forest products increasing.—Rising prices of lumber and other timber products, by increasing the cost of living, make it increasingly difficult for our people to maintain a high standard of living. Notwithstanding the use of many substitutes for wood, such as concrete, brick, stone, and stucco, wood is not decreasing in importance in modern economic life. It is the *diminishing supply and lessened availability* of timber that threaten.

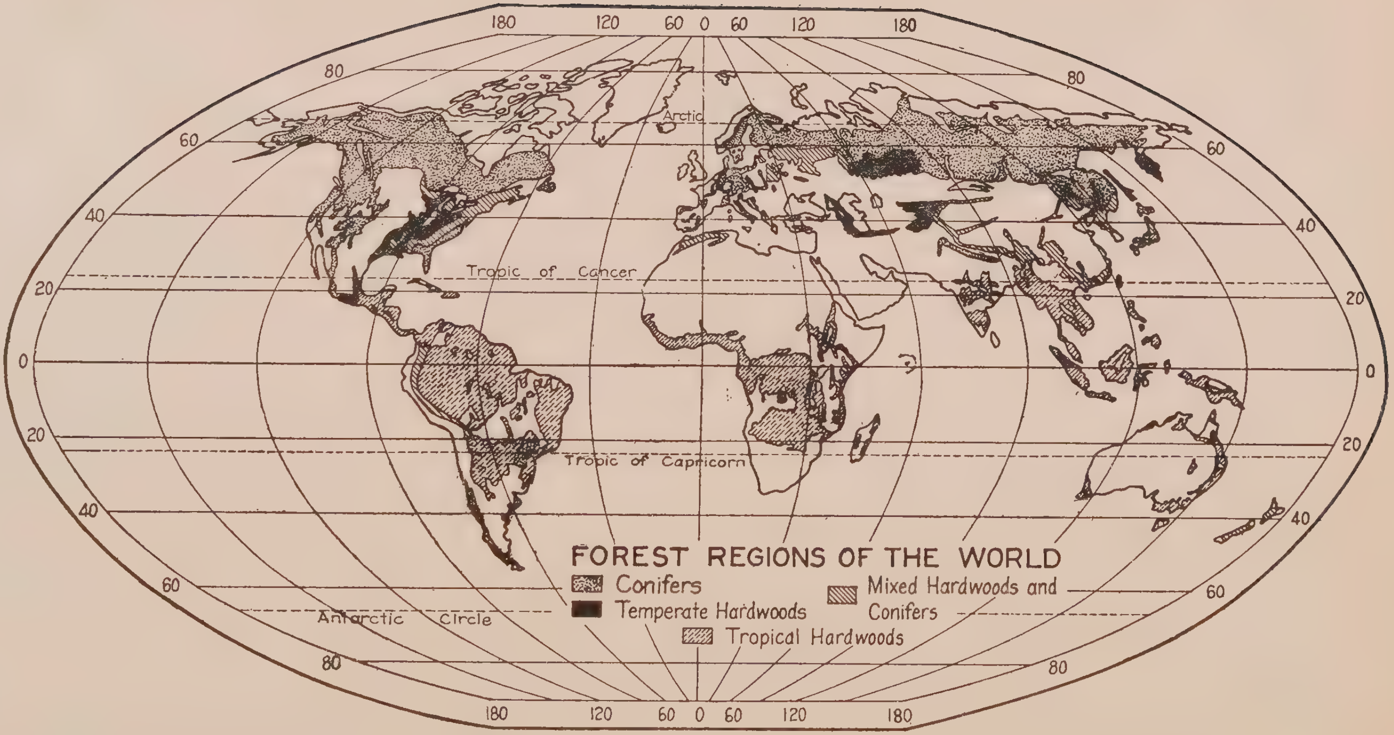
Besides using one-half the world's consumption of saw timber and one-third of all the fuel wood, the United States is the leading producer of turpentine and rosin (" naval stores "), which are forest products, as also are tanning materials, tar, wood alcohol, and creosote. Then, too, this country's yearly requirement of 8,000,000 tons of paper supports an immense wood pulp industry, which depends for its raw material chiefly on the forests of spruce, hemlock, aspen, and balsam fir. Ninety-five per cent of all the paper made in the United States is made entirely, or in part, from wood pulp. Many other things of everyday use are of little suspected forest origin, such as varnish, artificial silk, carpets, rope, gas mantles, hair brushes, and moving picture films. The United States uses nearly as much wood as all the rest of the world combined. We are consuming our forest resources five or six times as fast as they are being produced. That means, of course, that sooner or later we shall be faced by a timber famine, unless steps are taken to remedy the situation by a wider and better utilization of our idle forest lands.

The timber resources of the rest of the world.—It is often thought that we can solve our timber problem by imports from other countries. As a matter of fact, we annually export more than we import. This condition doubtless will soon be reversed. But it is not probable that we can depend upon imports to supply our needs, if our timber resources should be exhausted.

Two-thirds of the timber consumed in the United States is soft wood, such as pine, hemlock, spruce and fir. But in this softwood or coniferous timber the world is faced with a timber shortage. The pines, spruces, firs and other coniferous softwoods are found chiefly in the north temperate zone, the home of most of the highly developed civilizations. There are vast, almost untouched, areas of timber in the tropics, but those are chiefly hardwoods. (See Fig. 79.)

Many countries with *large areas of hardwoods,* such as India, Indo-China, the East Indies, and Australia, import softwood from Canada, the United States, and the Baltic countries for construction purposes. Because of its lightness, strength, and ease with which it can be worked, coniferous softwood is considered far superior to hardwoods for purposes of construction. Of the world's total land area about 6½ billion acres are in forest; 2¼ billion acres in the temperate zone, and 4¼ billion in the tropics. Of the temperate forests, not over 1⅗ billion acres are in coniferous forests. So the world's hardwood areas are over three times those of the conifers. But the world's consumption of temperate softwoods is ten times that of tropical hardwood.

Comparable to the originally great softwood forests of the United States, there are but *three other great bodies of coniferous timber* in the world. One is in Alaska and Canada; the second, which is the greatest, extends from Scandinavia eastward through Finland, Russia, and Siberia to the Pacific; and the third, of much less importance, lies in central and southeastern Europe, chiefly in Austria and Hungary. Before the Great War, Austria-Hungary was over-cutting its forests. It is not likely that this forest region will long produce more than its domestic needs. Norway and Sweden have only a small surplus of structural timber. Their exports are largely pulpwood and pulp. So Finland and Russia are the only European countries which have large surplus resources of construction timber to export, and that is likely to be taken mostly by their near neighbors. Of Canada's vast softwood forest area much is in the Arctic region and is of doubtful availability for export. Her more accessible forests are being utilized



After a map in Zon and Sparkawk's "Forest Resources of the World."

Fig. 79.

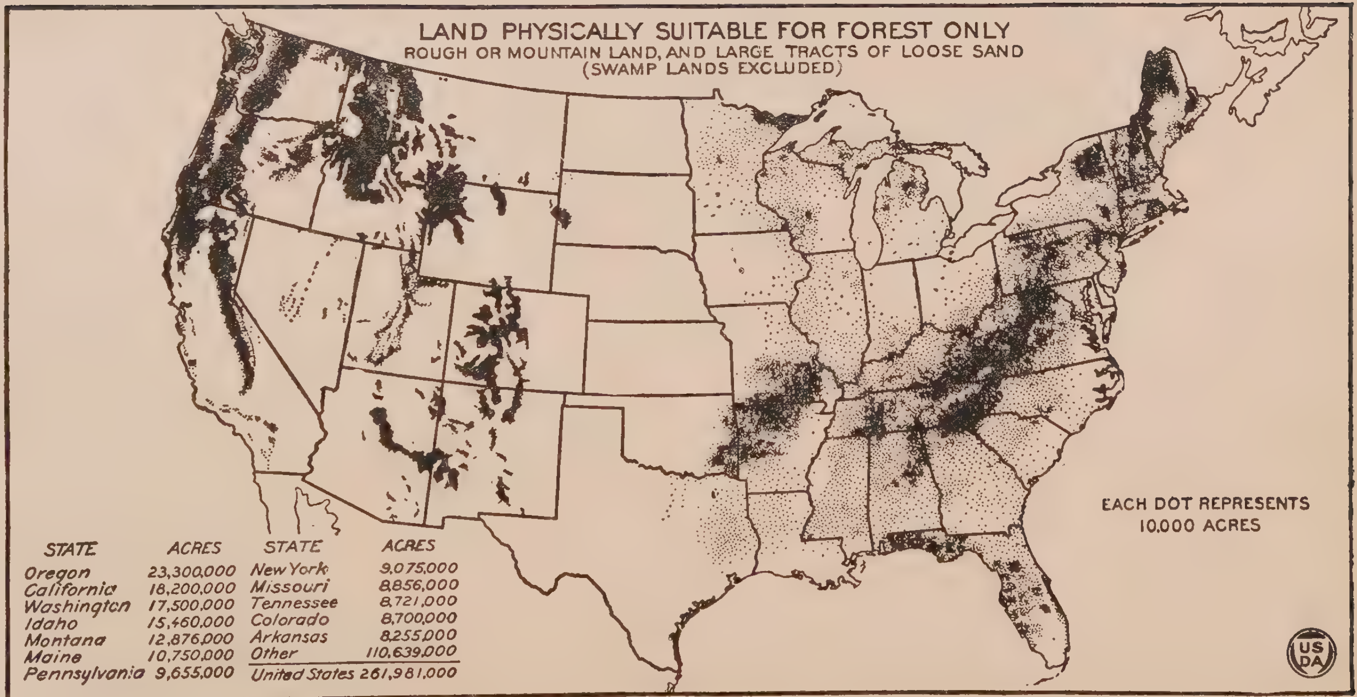
largely for needs of the British Empire. Much of the Alaskan forest is better adapted to pulpwood than to lumber.

The billion acres of *Siberian forest lands* contain vast undeveloped timber resources. But much of this is in Arctic and inaccessible interior regions and may never be available for export to eastern America, even could the lumber stand the high transportation costs. The forests of Siberia close to the Pacific are near industrial Japan and awakening China who are likely to be the first bidders for the increasing forest exports of Siberia. Just as most of the countries around the Atlantic ocean depend on coniferous timber from the United States, Canada, Scandinavia, and the Baltic States, so the countries around the Pacific (as their hundreds of millions of people realize their industrial destiny), will find the now scarcely touched coniferous forests, tributary to the Pacific, of vital importance to their national progress and permanent welfare.

It appears, therefore, very improbable that the great future timber demand of the United States, the *world's greatest consumer,* can be supplied by imports from other countries, except to a very limited extent and at prohibitive prices.

Better Utilization of Our Forest Lands.

Timber crops and conservation the solution.—As abundant supplies of timber are necessary to maintain our present standard of living, and since our growing population will require even more wood in the future, the fact that we cannot expect more than temporarily to secure timber by importation means that we shall soon have to reduce our timber consumption to our production, or manage to bring the timber production up to the consumption; at least our timber budget must be balanced. Now the timber consumption is due both to use and to waste. The waste arises in cutting and logging, in milling and manufacture, in losses due to turpentining, and largely to forest fires. If we eliminate or at least minimize these wastes, and practice reasonable thrift in utilizing our forest lands, in growing timber as a crop, it is estimated that


LAND PHYSICALLY SUITABLE FOR FOREST ONLY
ROUGH OR MOUNTAIN LAND, AND LARGE TRACTS OF LOOSE SAND
(SWAMP LANDS EXCLUDED)
EACH DOT REPRESENTS
10,000 ACRES
US DA

STATE	ACRES	STATE	ACRES
Oregon	23,300,000	New York	9,075,000
California	18,200,000	Missouri	8,856,000
Washington	17,500,000	Tennessee	8,721,000
Idaho	15,460,000	Colorado	8,700,000
Montana	12,876,000	Arkansas	8,255,000
Maine	10,750,000	Other	110,639,000
Pennsylvania	9,655,000	United States	261,981,000

From Yearbook of U. S. Department of Agriculture, 1923.

Fig. 80.—Land in the United States Suitable Only for Forests.

those lands can ultimately be made to produce a continual timber supply beyond our present need.

The growing of timber is a slow process, however, and many years of timber shortage and high prices are inevitable in spite of the utmost that can be done, before we can make our forest lands produce, through growth, as much timber as we now take from them.

As experts of the United States Forest Service express it:

> " Even if intensive forest management could be applied instantly to the entire area of forest land in the United States, it would take a generation or two to bring about forest conditions as favorable to high production as those now to be found on small areas in this country or over large areas under forest management in Europe.
>
> " This production, however, cannot be brought about in a short time. To make the practice of intensive forestry universal, or even the rule, throughout the United States will be possible only through gradual progress. It will require the development of scientific knowledge and technical methods of timber growing comparable with what has slowly and at large cost been obtained for agricultural crops. It will require effective protection against fires. It will require methods of cutting the mature timber that assure prompt and complete reforestation. It will require the selection and concentration of growth on the best species in each region. It will require cultural operations, such as thinnings, which in European countries yield, and in this country may be expected to yield, a revenue from forest land before the main crop reaches maturity. It will require a cut so regulated that only the mature timber will be taken, and no more than the total growth of the whole forest."[4]

The outlook for the future.—It has been seen that the threatened depletion of timber in the United States has resulted not so much from the utilization of our forests as from their devastation. The *crux of the problem* lies in the fact that great areas of forest land are not producing the timber crops that they should. The vast area of our forest land not required for any other economic use is estimated at 463,000,000 acres and perhaps half of this is absolute forest land, that is, not suitable for other crops. See Fig. 80. This area will provide for our future needs if it is kept productive. But there are at least three factors which tend to prevent the conservation practices which would bring about the maximum production. These are: (1) private ownership of our forests, (2) the long time necessary to produce timber, and (3) excessive taxation of forest land.

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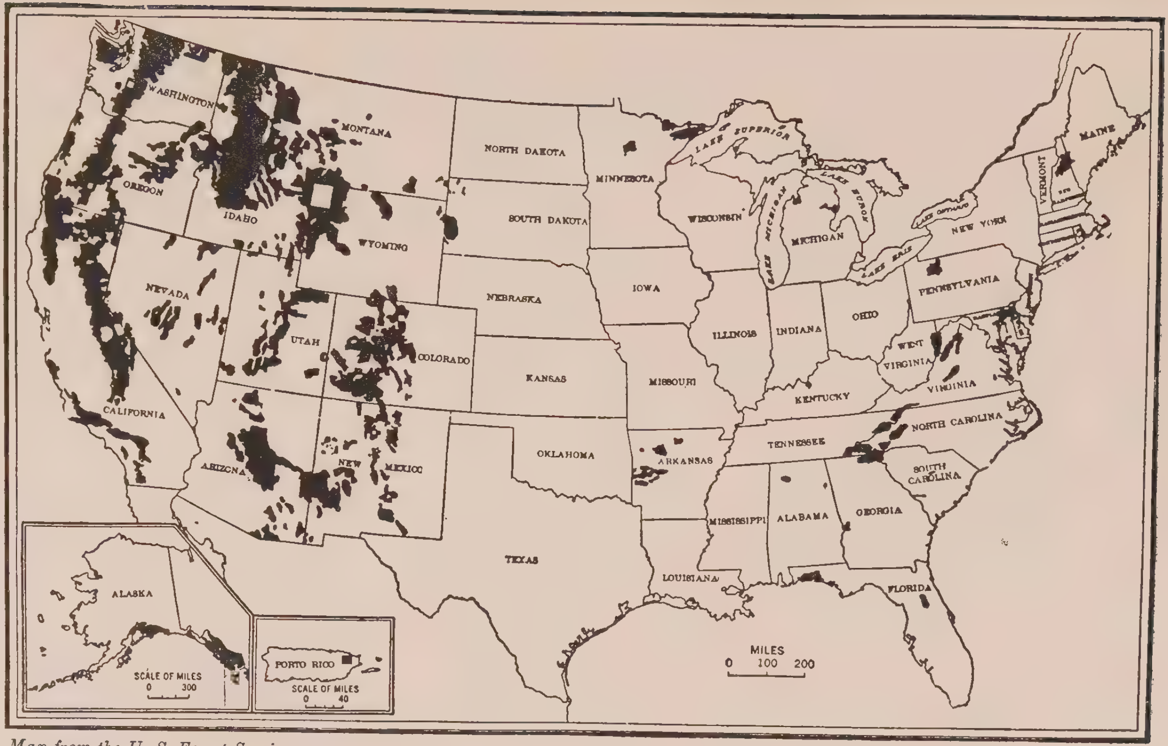
[4] " Timber: Mine or Crop? " W. B. Greeley and Others, pp. 139, 140.

Private owners want profits.—Four-fifths of our forests are privately owned. Private owners will practice conservation usually only if they consider that it will pay. As it takes from 30 to 150 years to raise a forest, the chances of a private owner's getting reasonable returns on his investment are dubious if interest charges are heavy and taxes are high. Nevertheless, in spite of discouraging conditions, the lumber and timber companies and private owners have been making steady progress in protecting their forest lands from fire; in selective cutting of timber so as to leave smaller trees to grow with a view to a permanent yield; and in artificial planting and the encouragement of natural reforestation. Many of these industries realize now that their perpetuation is dependent on forest growing. Probably 200 million acres of forest land are now under some sort or degree of private fire protection.

In many cases, however, the rugged topographic conditions of the forest lands, or the slow and scanty timber growth on the lands due to lack of rainfall, or other unfavorable conditions, make it inevitable that the private owner would never find timber growing, on certain lands, a sound investment. Here the government, not subject to the limitations of time and death, finds its opportunity in gradually acquiring forest land and operating public forests. Then, too, it can aid forest conservation greatly by assuming greater responsibility for aid in fire protection, and in relief from excessive taxes on timber lands. Often, a private owner finds the taxes higher on his forest lands simply because the timber is there. Moreover he must pay this tax every year while the timber stands, so he is tempted, or compelled, to cut it at once, for fear of losing money by letting the timber grow.

In 1924, the Congress passed the *Clark-McNary Forestry Law* by which the federal government co-operates with the states in extending protection and management aid, as well as



Map from the U. S. Forest Service.

Fig. 81.—The Distribution of the National Forest Reservations of the United States. (Compare with Fig. 80.)

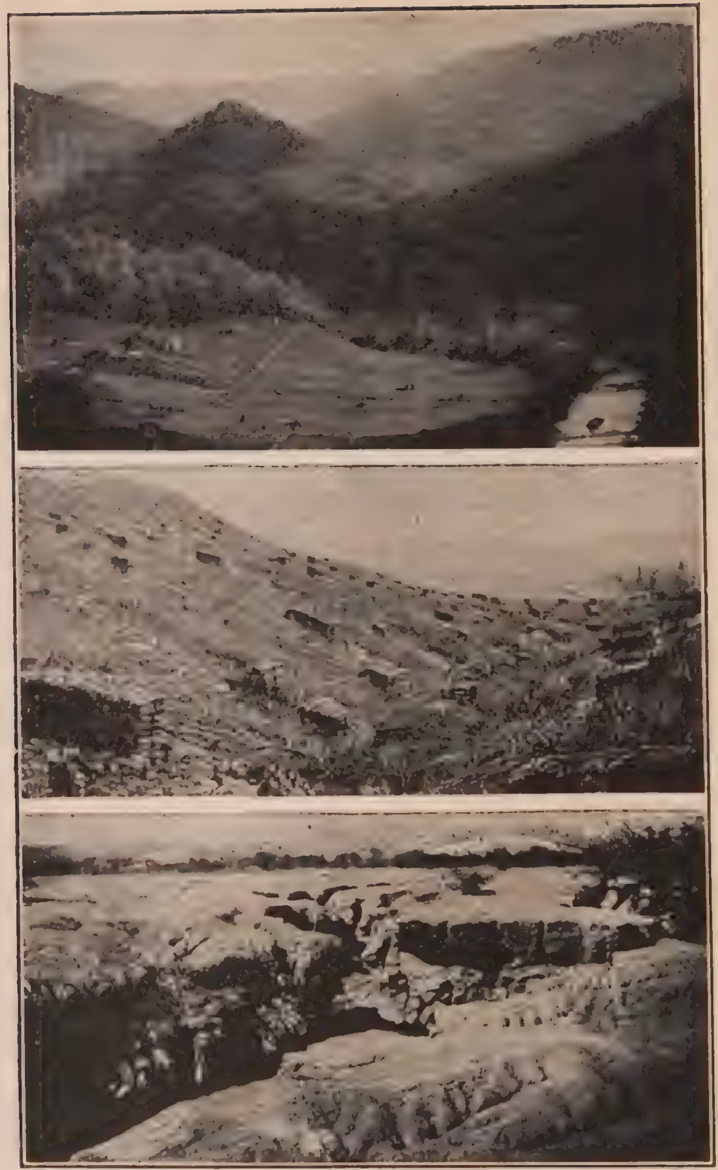


Fig. 82.—Effects of Forest Removal from Hilly Land.

Upper.—Forested slopes on mature topography. (Photo by U. S. Bureau of Agricultural Economics.)

Middle.—Deforestation. (Photo by J. C. Brown, U. S. Geol. Survey.)

Lower.—Denudation followed by gulleying and destructive erosion. (Photo by U. S. Bureau of Agricultural Economics.)

some taxation relief, to timber growing lands under private ownership. This is simply another milestone on the long road of progress made by our national government in its policy of forest conservation.

Since a law passed in 1891 permitting the President of the United States to set aside from our public lands *National Forest Reservations,* our national forests have come to number 159 with a total area of nearly 159,000,000 acres.[5] One president alone, Theodore Roosevelt, set aside over 148 million acres during his term of office. These national forests are mainly in the west and largely on lands suitable almost entirely for forests. (See Figs. 80 and 81.) Their efficient administration by the United States Forest Service has contributed greatly to the forest conservation movement in this country; to the recent interest of private owners of forest land in timber growing; and to the education of our citizens in general as to its importance to our national welfare, in the way of timber supply, prevention of erosion of land on steep slopes, regulation of stream flow, and protection of water supplies through the maintenance of forest cover on watersheds. City dwellers see the value of forest growths in recreation parks, assured water supplies and lessened danger from floods.

Farmers find the *farm wood lots*[6] a valuable source of timber for farm use and effective wind breaks for buildings and crops, while the western ranchmen see that forest maintenance contributes to the grazing industry invaluable assistance in the way of pasture and water for live stock. (See Fig. 67.) Even some of the semi-arid lands of the west are finding increased possibilities of income and human enjoyment from forest utilization of waste land.

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[5] 158,800,424 acres, including 21,340,392 in Alaska, June 30, 1927; *U. S. Year Book of Agriculture,* 1927, p. 1198.

[6] In 1925 the total woodland on farms consisted of 143,794,192 acres, of which 67,090,246 acres were pastured; *U. S. Year Book of Agriculture,* 1927, p. 1204.

Chapter XI

UTILIZATION OF LAND FOR AGRICULTURE

Agricultural Land.

Agricultural uses of land.—The principal agricultural uses of land are for crops and for pastures. These uses are in part competitive and in part complementary in their land requirements. For example, if land is physically suitable for crops and for pastures, it is said to be competitive in its use; while land employed for crops and for pastures at the same time is complementary in character. Much of the humid land may be used for both crops and pasture, either in rotation or as permanent crop or pasture land. Nearly all of the arid or semi-arid lands of the temperate belts and, to some extent, such lands found in the tropical zone are capable of being employed for pasture. However, only a limited portion may be used for crops, where rainfall, topography, and soils are favorable. On the whole, the complementary use of land is not as extensively practised in arid or semi-arid land as in humid land.

Extent of agricultural land.—An estimation of the developed and potential agricultural land is recorded in the following table. An analysis of this table reveals the presence of large undeveloped agricultural areas in the tropical belt. Here, in general, the population is sparse and as a consequence the land suitable for tillage, or potentially arable land, per person is high. In the temperate belts the opposite is true. But there is more than twice as much land under cultivation in the temperate belts as in the tropical belt.

Agricultural activities.—The major agricultural activities are: (1) general farming, (2) specialized crop farming, (3) live-stock farming. A person engaged in the production of several different kinds of plants and animals is said to be practising general farming. The growing of one or two crops such as cotton or wheat is recognized as specialized farming. Horticulture, a phase of specialized farming, consists of the business of growing trees or shrubs for fruit, for protection, for decorative purposes, or for raw material. Floriculture is a highly specialized form of agriculture which concerns the production of flowers. The live stock industry includes the production of animals for food, raw material, or burden bearers.

ARABLE LAND OF THE EARTH[1]

TROPICAL BELT	
Total land area	23,000,000 sq. miles
Land too arid for crops	8,000,000 " "
Land with adequate rainfall	15,000,000 " "
Land probably one-third ultimately arable	5,000,000 " "
Land cultivated at present	1,200,000 " "
Arable land in pasture	600,000 " "
Potentially arable not used for crops or pasture	3,200,000 " "
TEMPERATE BELT	
Total land area	29,000,000 sq. miles
Land too dry for crops	7,600,000 " "
Land too cold for crops	6,400,000 " "
Land with adequate rainfall and heat	15,000,000 " "
Land probably one-third ultimately arable	5,000,000 " "
Land cultivated at present	2,500,000 " "
Arable land in pasture	1,500,000 " "
Potentially arable not used for crops or pasture	1,000,000 " "

Since nearly one-half of the world's population is engaged in agriculture, it is logical to expect considerable differences in the character of the agricultural practice.

The caribou industry of the far north, the sheep raising in southern Chile, the vast wheat fields in Canada, the United States, Argentina, and Australia, the corn belts of the United States and Argentina, the coffee plantations of Brazil, the tea crop of Ceylon and China, the henequen production in Mexico, the rubber plantations of the West Indies, the banana culture in Central America, and the potato crop of Maine, illustrate some of the differences in the types and places of agricultural activities. (See table.) Moreover, the methods of conducting agriculture figure widely in many localities. On the one hand, there are the scientific and efficient methods of farming carried on in the United States, and on the other hand there exist the crude and inefficient agricultural practices in China. The American farmer plows twenty or thirty acres, with his modern tractor, in one day; while in China, the farmer spades two or three acres in a season. The reaper-thresher combination used in the United States, and other countries of progressive agriculture, is in striking contrast to scythe and flail employed in many of the regions of primitive agriculture in China. Why is there such a marked improvement in agricultural methods in some places and almost stagnation in others? Also, why is there a difference in the place and type of agriculture? These questions can, in part, be answered on the basis of the geographical factors in agriculture.

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[1] Taken from: O. E. Baker, "Land Utilization." *The Geographical Review,* Vol. XIII, Jan. 1923. No. 1.

Geographic Factors in Agriculture.

Factors of location.—The location of agricultural land, *with reference to a city,* is a matter of geographic importance. Since the agriculturist is the producer of food and raw material that the city folk consume, the distance between the two parties may influence the type, amount, and price of agricultural products. In general, farm land near cities is employed either for general farming or for specialized crop farming. Truck gardening, fruit growing and diversified dairy farming are types of agricultural activities found within short distances of cities. The garden area of western Long Island is an example of one of these types. The great city of New York offers an excellent market for fresh vegetables. These products can be supplied by the farmers of western Long Island at a relatively low cost and in a fresh condition, which the short distance between the consumer and producer makes possible.

But nearness to city markets has some agricultural disadvantages. Land values and labor conditions are generally unfavorable for farming. Often the land increases in value to the extent that the farmer sells to a realty company. Thus, all agricultural activities on such land may stop or be carried on by a tenant farmer to whom the land has been rented until it warrants subdivision into building lots. Also, a farmer operating near a city may find it impossible to compete with wages paid in the city. As a result he either has a considerable labor turnover, or he does not have any one working for him at all. These conditions, in part, account for the presence of so many neglected farms near cities.

MAJOR TEMPERATE AGRICULTURAL PRODUCTS
AVERAGE PRODUCTION FOR 1921–25

Country[2]	*Millions of Bushels*				*Cattle* (000)	*Hogs* (000)	*Sheep* (000)
	Wheat	*Corn*	*Rye*	*Potatoes*			
World Total	3,653	4,416	1,498	6,312	629,000	255,400	592,000
United States	804	2,851	68	395	65,421	61,604	37,215
Canada	374				9,588	4,344	
European and Asiatic	358	134	619	1,496	59,287	19,169	104,191[4]
India	336	82					
France	291		41	451	13,582	5,302	
Argentina	203	223			37,065		36,209
Italy	198	96					12,014
Spain	142		28	98		4,500	19,252
Australia	129						
Brazil		177			34,271[3]		
Rumania		140					11,660
Yugoslavia		109				2,433	
Germany	99		256	1,304	16,786		
Poland			200	978	8,473	5,642	
Czechoslovakia			52	247			
Hungary			22				
Lithuania			23				
Belgium			21	108			
Mexico		84					
Java and Madura		64					
Netherlands				109			
Uruguay					8,117	16,169	14,443[2]
Union of South Africa					9,342		32,522
Denmark						2,314	
United Kingdom						2,959	21,681
Peru							11,363

[2] Ten leading countries listed.
[3] Census 1921.
[4] Includes goats.

Agricultural lands at *great distances from the consuming centers* are characterized by extensive farming. Large areas are used in the production of specialized crops that will stand a long shipment such as wheat, cotton, coffee, and rubber. The beef cattle industry, and the raising of sheep are other important agricultural activities of the distant lands. With the increasing improvement in highways and trucks, the dairy industry is moving away from the populated centers.

The location factor, distance, is not as effective as it was before our present efficient means of transportation. To-day *accessibility* is more important. If a farm can be easily reached, it has almost immediate access to the best markets. Also, a farm within reach of the automobilist, even at great distances, can sell its products from the so-called road-market stand. The great variety of food included in the daily diet is another illustration that distance does not prevent the distribution of fresh or perishable products for human consumption.

Climatic factors in agriculture.—Climate, in the main, *affects the general utilization* of land for agricultural purposes. The wheat areas of Canada, the cotton areas of southern United States, the banana fields of Central America, the camels of Mongolia, the reindeers of Greenland, and innumerable other illustrations, exemplify the relation of climate to agricultural activities.

Every plant and animal has an *optimum climate,* or climatic condition most favorable for its normal development. This so-called optimum climate varies greatly, at different periods of the activity of the plant or animal. The conditions that are most suitable in the youthful stage may not be most desirable during the mature period of life. For example, wheat requires a cool moist climate in its early growth period but during its mature stage, a warm dry climate is most suitable for the production of wheat of high quality. The general optimum climate for corn is a warm humid atmospheric condition. Camels and goats are distinctly products characteristic of dry regions. In a like manner every other plant and animal has its most favorable climate.

However, not all plants and animals are produced under their optimum climate, because other factors, in addition to the climatic elements, are related to the production of plants and animals. A study of production figures, as in the above table, in conjunction with the climatic regions of the world,

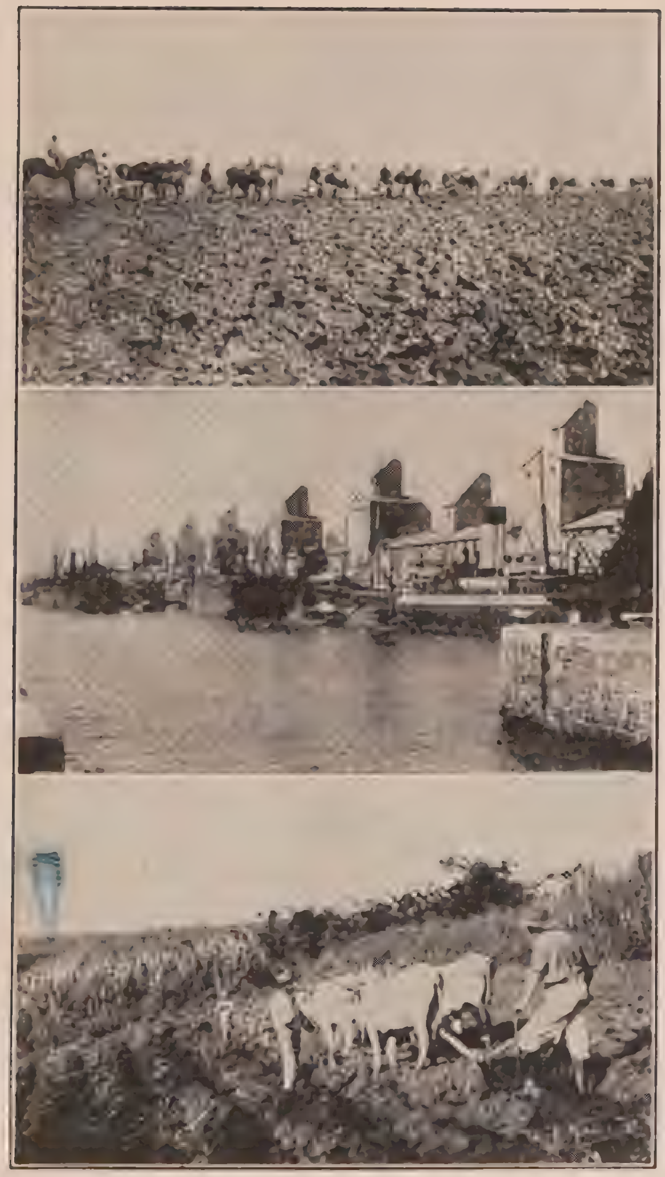

Fig. 83.

Upper.—Plowing for wheat, Argentina.
Middle.—Storage elevators for wheat, Buenos Aires.
Lower.—Opening furrows for planting sugar cane, Brazil.

will facilitate a better understanding of the relation of climate to the utilization of land for agriculture.

Land forms and agriculture.—*Plains and valley bottoms* are the principal seats of agricultural activity. The relatively uniform and level surface encourages large-scale operations with the use of modern farm machinery. The central plains of the United States, the Hungarian plains, the pampas of Argentina, the valley of the Ganges river, the Connecticut valley, and the San Joaquin valley bear out this assertion.

Mountain slopes, hills, and *plateaus,* or the lands of rugged relief are areas that are not generally chosen for farming, but are regions that man is at times forced to use for agricultural purposes. This is not true in all cases, as there are moderate forms of relief which are outstanding in their favorable conditions for agriculture. For example, the production of coffee, tea, and fruits, in general, are best suited for hill slopes. Here, there are fewer possibilities of frost, better light conditions, and more satisfactory soil drainage; all of which are essential factors in the cultivation of many plants. The grazing industry is another phase of agriculture that may be successfully conducted in areas of irregular topography.

In addition to the effects of relief on type or quality of production, it also affects the amount of agricultural land available and the method of using it. The *area available* for farming in rugged topography is limited by steep slopes, thin soils, inaccessibility, and climate. As a result, in mountainous or hilly regions where climatic conditions are favorable, agriculture is conducted with pronounced intensity and with the use of very little machinery. In order to overcome some of the topographical handicaps, the fields are often *terraced,* thus reducing the degree of slope. This is sometimes done to economize space, sometimes to utilize sunny slopes, sometimes to lessen soil erosion. (See Fig. 84.)

The *thin soil* so often found on steep slopes is another agricultural disadvantage. Roots cannot penetrate far enough to give the necessary support to the plants. Hence, this type of farming may be confined to shallow rooting plants, such as the cereals and grasses. The likely inaccessible nature of relief

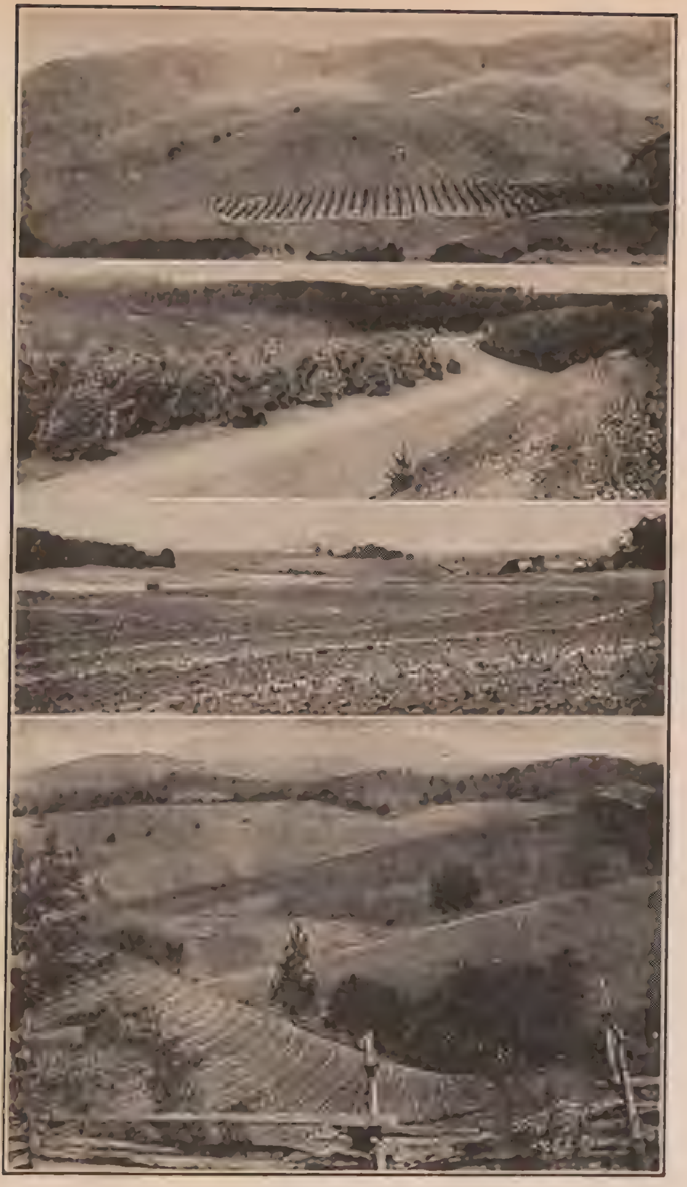

Fig. 84—The Problem of Soil Erosion.

Upper.—Beginning reforestation on denuded and badly eroded upland. (Photo by courtesy of U. S. Bureau of Agricultural Economics.)

Beneath.—Reforestation on York, Pa., watershed. White pine on left side of road; red pine on right; planted about twenty years ago. (Photo by courtesy of U. S. Forest Service.)

Middle and bottom.—Terracing to prevent erosion on mature topography. (Photo by courtesy of U. S. Bureau of Agricultural Economics.)

introduces difficulties of building good roads. Consequently, transportation facilities which are generally poor, indirectly lower the utilization of land for agriculture.

Soil as a geographic factor.—Having discussed the broad and general environmental elements such as location, climate, and land forms in their relation to the utilization of land for agriculture, our attention is now turned to a more detailed and specific factor; namely, *soil*. There is no environmental element that is any more significant in the activities of farming than soil. Climate, topography, and water may determine somewhat the limitations of man's agricultural affairs, but soil governs largely the nature of these activities. Within a small area, such as the land of a typical American farm, it is soil that reveals the true character of the agricultural possibilities. Wheat, corn, potatoes, and the like are not grown by a scientific farmer here and there without consideration of the type of soil. The farmer selects the soil which is best suited for specific purposes.

Soil may be characterized as the fairest index of the nature of nearly all environmental factors, as it constitutes a body of material which is largely the resultant of the activities of climate, land, water, plants, and animals.

The geographic importance of soil is not as pronounced or noticeable as those of climate and relief but it is equally significant. Change in the atmospheric conditions, or a difference in the character of the surface of the land is recognized by the most casual observer; but a change in the qualities of the soil is usually passed unnoticed except by the soil specialist. Still the difference in the soil may have a greater influence on man's activities than the climatic or topographic variations. One reason for the apparent ineffectiveness of soil is due to the soil's influence being decidedly indirect, rather than direct, as so frequently appear to be the effects of climate and land forms.

Nature of Soils.

Soil characteristics.—To characterize soil as "dirt" or "inert material" is an open confession of one's ignorance of the nature of soil. Much to the contrary, soil is dynamic, active, and functional. It consists of physical, chemical and biological attributes. The nature of these constituents gives soils their so-called key or identification characteristics; such as, color, structure, texture, and certain chemical, biological, and profile properties.

1. The *color* of the soil, like the color of animals, is generally indicative of specific functional characteristics. It may disclose some information about the productivity and adaptation of the soil. The amount of organic matter and the tilth conditions of the soil are sometimes revealed by the color. There are two general classes of soil based on color: (1) dark colorations, the tints ranging through reds, browns, yellows, and grays. As a rule, the dark soils are high in organic matter, fertile, and easily tilled. The light-colored soils are generally opposite in character, being low in humus and fertility, and less responsive to good tillage.

2. The *structure* of the soil has reference to the arrangement of the individual particles. It may be blocklike, cloddy, nutlike, granular, columnar, or platy. A soil of poor or imperfect structure does not have favorable respiratory or aëration and circulatory systems. The soil must breathe. It needs fresh air to bring about necessary processes of oxidation and digestion. At least 50% of the pore space should be filled with air. In a like manner, the soil moisture must circulate through its structure, to distribute the nutrient material and eliminate the waste products.

Soils with poor structure are hard and refractory when dry, plastic and intractible when wet, and form lumpy, cloddy surfaces when turned in plowing. Their drainage conditions are generally poor and they do not respond successfully to fertilizers. But the perfect structural soils are easily worked, form a smooth crumbly seed bed, and respond to amendments or fertilizers.

3. The *texture* of soil has reference to the coarseness or fineness of the individual particles. The constituents are classified into separates; known as, coarse, medium, fine, and

very fine sand, silt, and clay. Thus a soil is called a clay soil if its physical properties are predominantly clayey; a sandy soil is one in which the sand particles are outstanding; etc. A loam is a soil which contains the properties in about equal proportion of both the coarser materials such as the sands, and the finer materials, the clay and silt separates.

The textural character of the soil influences the type of agriculture. A sandy soil heats more quickly than a clay soil. Hence, the former may be used successfully for the growing of early crops. Clay soils are well suited for grasses and cereals. Loams are probably the most desirable soils for general purposes in having some of the properties of both sandy and clay soils.

4. The *chemical elements* of soils include primarily silicon, aluminum, iron, calcium, potassium, magnesium, nitrogen, phosphorus, and some rare elements such as titanium, chromium, vanadium, and nickel. The amount of silicon, aluminum, and iron are usually high, while the other elements are likely to be present in small percentages. The elements that are most generally deficient in an available form are potassium, phosphorus, and nitrogen. Thus, it is necessary to add these essential elements to many soils in the form of organic material or fertilizers. Calcium is another element that may be deficient in soils, not as a plant nutrient, but as an available base to correct certain detrimental chemical reactions in soils.

The chemical reaction of soils is a fundamental basis of soil utilization and classification. It may be viewed under two types (1) acidity and (2) alkalinity. Soils low in lime are usually acid in reaction, while a soil high in lime is characterized by alkalinity. Acid soils are poor soils and have a limited use. The acidity, however, may be corrected by the addition of lime or other soil amendments. Limy soils usually have good structure and fertile qualities. In the classification of soil, the presence or absence of lime is the basic characteristic as all soils may be grouped into one of these two divisions.

5. The *biological elements* in soils give it the properties of a living thing. Without bacteria and enzymes, the soil would be inert and inactive. These organisms have the power of

breaking down food materials for plant utilization. Not all forms of organisms found in soils are beneficial for the preparation of food for assimilation by the plant; some are decidedly injurious. Imperfect structure is often the reason for the presence of undesirable life forms in soils. Proper tillage and soil treatment can usually eliminate the harmful biological constituents.

6. The *soil profile and horizons* are other so-called keys or identification characteristics. Nearly all soils show some difference in the character of the material at various depths. At the surface, a soil may be coarse in texture and dark in color, while a short distance below its surface it may have the properties of light clayey material. These divisions are called horizons and usually the normal soil profile or cross section shows three major divisions: (1) "A" horizon or (soil), (2) "B" horizon or (subsoil), and (3) "C" horizon or (substratum). The *A* horizon is the portion that is generally cultivated. In humid regions it is not only being diminished in plant nutrients by cropping but also by percolating waters. The *B* horizons are areas of deposition as here the downward seeping water may deposit solids as well as soluble material, removed from *A* horizon. The *C* horizons represent the unweathered or parent soil material. The character of the horizons constitutes the base upon which soils may be distinguished one from another. However, some soils do not develop profile characteristics. Desert soils, swamp or muck soils, and tundra soils in their uncultivated condition, generally are found without profiles.

Stages of soil evolution.—Soils, like valleys or mountains, may be classified into stages of development such as young soils, mature soils, and old soils. Each stage is based upon characteristics and not age. That is, young soil may be older in years than a mature soil but owing to its location it has retained its youthful character; therefore it is called a young soil.

Young soils are more or less like the rock material or formations from which they were formed. They are found on hillsides and in flood plains where they are subject to rejuvenation by erosion and deposition. Mature soils have a more perfect profile than young soils. In character they have little resemblance to the parent material. Level and undisturbed areas represent the sites of mature soils. Old soils occupy regions where environmental conditions have been relatively stable for a long time. Many old soils have a tough, hardened *B* horizon or subsoil.

Classification of Soils.

"Good soils" and "Poor soils."—Probably the most practical classification of soils, at least one of the simplest, is the grouping of soils into two divisions: (1) good soils and (2) poor soils. Indeed, a good soil may not be favorable for all purposes, as also a poor soil may be undesirable for all kinds of agriculture. But, as a whole, a good soil is far superior to a poor soil in its geographic importance, when other conditions are the same. The fertile loam soils of the State of Pennsylvania, the sand hills of some of our southern states, and the rich black soils of Alabama are a few illustrations of the influence of good soils and poor soils on human progress.

The *success of the farmers* in the vicinity of *Lancaster, Pa.,* is attributed in part to their occupation of a fertile soil, known as the Hagerstown loam. The people who settled on this particular soil have established a standard for American agriculture which is recognized by every one with admiration. They have been able to feed themselves and to produce a considerable surplus for market purposes. Their land has increased in value; they have built comfortable homes and commodious barns; they are conducting their farming on a scientific basis; and the finest types of educational institutions have been built within their reach.

About the same time, some three or four hundred years ago, less fortunate colonists established themselves on the sand hills of some of our southern states. These people, many of the same stock as those who settled in Pennsylvania, encountered the difficulties of trying to make a living on poor soils. Their efforts were spent in vain, as then and now no one could get these soils to produce sufficient food and raw material without a financial loss. Consequently, they have become surrounded with evidences of poverty; such as, shacks for homes, dilapidated barns, and crude methods of farming. They have generally been poorly educated; they have frequently developed an attitude of laziness and discouragement; and in instances they have become a national burden and menace.[5a]

Alabama offers another pertinent example of the part the soil has played in the development of human relationships. Three main geographic areas may be distinguished in this interesting state. The northern half of the state has poor soil, and is relatively rugged. The central part of the state consists largely of the black belt or region of fertile soil. In the south are found the infertile lime hills and poor sandy soil of the southern pine belt. The "black belt" of fertile soil is occupied by a few rich, well-educated, and conservative whites, and numerous poor, ignorant, and incompetent negroes. The white aristocracy hold possession of the land and rule over the black people. In the regions of poor soil, referring to the northern and southern areas of Alabama, the class distinctions are less extreme. Land is owned and operated by both the whites and blacks; the difference in educational and other several accomplishments is less. The poor soils are not productive enough to bring the financial returns that are necessary for building fine homes and educational institutions.[5b]

It is not necessary to go far from one's home to observe influences of soils as striking as those recorded in regard to Pennsylvania and Alabama. Houses and barns furnish one of the best measures of prosperity. Wherever these signs show poverty, it is a fair indication that the soil is poor. True, there are many exceptions where soil conditions are favorable, but the signs of prosperity are lacking. These conditions may be explained on the basis of inefficient management, negligence, or adverse economic situations. In general, the quality of the soil is expressed in the character of rural life.

[5a] Whitney, "Soils and Civilization."

[5b] Since this paragraph was written, Doctor Carlson has made a detailed study of Alabama. He points out that the soils of the northern half of Alabama are not universally poor and that less emphasis should be placed on soils in this region and more attention given to the past accessible nature of the country.

Parent soil material as basis of soil classification.—It was formerly thought that soils inherited their characteristics from the parent material. Hence, soils were classified *on the basis of their origin* into (1) residual soils, and (2) transported soils. The former group had reference to soils formed in place. For example, the disintegration of a rock results in the formation of material *in situ,* or a residual soil. The transported soils include alluvial or water-born soil, æolian or wind-carried soil, glacial or soil formed by ice erosion and deposition, and colluvial or soil transported by gravity.

Classification on basis of origin is not satisfactory.—While this classification reveals the geological origin of the soil, it does not disclose the characteristics of the soil which determine its agricultural value. A residual soil formed from limestone does not necessarily contain any lime. The soils of the Shenandoah Valley and the Kentucky Blue Grass region are derived from limestone but they are deficient in lime and respond to lime treatments. Also soils of different origins formed under like climatic, topographic, and vegetative conditions are usually similar in character. At least they bear a closer resemblance to each other than they do to their respective parent material. In order to consider the soil itself, another and a more recent classification is proposed; one based upon the characteristics of the soils.

Climatic soil groups.[6]—Climate is the most important soil-forming agent. It determines the nature of the disintegration of parent material and the character of the resultant soil. Thus, in general, areas of like soils correspond in location to regions of similar climate. For example, the soils in different tropical deserts are very much alike; the cold temperate coniferous forest regions have soils of striking similarity; and the soils of the warm, rainy tropics are found to be similar.

Despite the close relation between climate and soils, it does not mean that soils are here classified on the basis of climate. True, there is a coincidental distribution of climatic regions and soil groups but *the fundamental factors* involved in the classification of soils are their characteristics; as, color, structure, texture, chemical and biological elements, and profile.

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[6] Based upon "Major World Soil Groups and Some of Their Geographic Implications" by Louis A. Wolfanger. *Geographical Review,* January, 1929.

The *two major soil divisions* are (1) lime-accumulating soils in their stage of maturity, and (2) those without lime. This grouping is as general as the classification of the lands of the earth into (1) highlands, and (2) lowlands. The subdivisions of the major soil groups are shown in the following:

THE CLASSIFICATION OF SOILS.[7]

- I. Lime-accumulating soils (grass soils).
  - A. Desert or grayerths (vegetation scant).
  - B. Semiarid or chestnuterths (light grass cover).
  - C. Subhumid or prairie.
    - 1. Chernozems—(medium grass).
    - 2. Prairyerths—(heavy grass cover).
- II. Non lime-accumulating soils (forest soils).
  - A. Hot-humid tropical or laterites (equatorial forest cover).
  - B. Cool-humid or podsols (coniferous forest cover).
  - C. Cool-humid or gray-brownerths (deciduous forest cover).
  - D. Warm-humid (subtropical) or rederths (mixed forest cover).

Lime-accumulating soils.—The lime-accumulating soils occur in *regions of light to moderate rainfall.* They have developed, largely, under grasslands or desert conditions. A high fertility and a favorable tillage quality are the most significant properties of lime-accumulating soils. The presence of adequate plant nutrients, such as nitrogen, phosphorus and potassium is attributed to the low rainfall conditions and the high rate of evaporation, so often found in the areas of light to moderate precipitation. The concentration of soluble salts in the *A* and *B* horizons is due to the absence of percolating waters to dissolve and carry away the essential plant elements. Also the high rate of evaporation increases the movement of water from the lower strata to the surface soil where the soluble constituents are precipitated. In some cases, the alkalinity reaches a degree which is injurious to plants, especially in the desert and semiarid regions. The color of lime-accumulating soils ranges from the light desert soils to the black soils of the grass plains.

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[7] This classification of soils is based upon mature soils.

The most *disadvantageous geographic factor* concerning these soils is their location in regions of relatively low rainfall, which limits agricultural production. The nature of this limitation is discussed in the treatment of the subdivisions of the lime-accumulating group; namely, the desert soils, semiarid soils, and the subhumid soils.

Desert soils or grayerths.—Desert soils are generally light in color with tints of gray or brown. The presence of lime and other valuable soil constituents makes *these soils fertile.* Their surface characteristics vary from fine pebbles to very fine sand and usually the texture is uniform and the structure free from hard layers of clay. The desiccated nature of the regions, in which these soils occur, accounts for the *scattered and scant vegetation.*

Few people occupy the desert soil areas except in centers of irrigation, such as the valley of the Nile. Pastoral nomadism is another type of human activity in regions of desert soils, pedagogically called grayerth.

Semiarid soils or chestnuterths.—The semiarid soils do not differ very much from the desert soils. They are, on the average, *darker in color,* ranging from brown to chestnut; their organic content is higher; and the concentration of alkalies is less than that found in desert soils. Although the rainfall is light and deficient for general farming, it is sufficient to maintain a cover of grass which invites the pastoral activities. But as found in desert areas, the *grazing industry* is *generally nomadic* in character. Dry farming and irrigation projects are utilizing limited areas of the semiarid soils.

Subhumid soils or chernozems and prairyerths.—Between the semiarid and humid lands are found *the prize soils* of the earth known as chernozems and prairieerths. They represent *the great grain belt soils* of Eurasia, North America, Argentina, and Australia.

Dark color, perfect structure, and fertility are the main characteristics of the subhumid soils. The chernozems tend somewhat in character to the semiarid soils while the prairieerths merge into the humid soils. Thus the chernozems are not always located under favorable climatic conditions due to the deficiency in rainfall. The prairieerths are better suited for general agriculture in having a sufficiency of rain. The greater portion of the corn belt occupies the area of the prairieerths. Chernozems are well supplied with lime but the prairieerths may be deficient in this valuable soil amendment. In both cases, there is a high humus content, and a sufficiency of available plant nutrients in uncropped regions. Collectively, the chernozem soils and the prairyerths are the most naturally productive soils of the earth.

Non lime-accumulating soils.—The non lime-accumulating soils or soils without lime develop in *regions of moderate to heavy rainfall* and *under forest cover.* They are usually poor soils, at least, less fertile than the lime-accumulating soils. Lowness in lime, acidity in reaction, and deficiency in available potassium, phosphorus, nitrogen, and humus are their characteristics. Their structure is usually coarse and is said to be nutty and cloddy. Grays, yellow, reds, and light brown are the prevalent colors of these soils. The principal classes of non lime-accumulating soils are: (1) hot-humid soils or Laterites, (2) cold-humid soils or podsols, (3) warm-humid soils or Rederths, and (4) cool-humid soils or gray-brownerths.

Hot-humid soils or laterites.—Much to the contrary of popular opinion, the *soils of the hot rainy tropics are poor* soils, and not well suited for agriculture. Laterites (as these soils are known) develop under a canopy of tropical vegetation and a heavy rainfall.

The heavy precipitation has thoroughly *leached* and carried away the lime, potassium, phosphorus, nitrogen, and humus. Though there is an abundance of vegetable matter, it does not accumulate in an undecayed state as found in prairie soils but it decomposes almost immediately and the soluble constituents are lost. Also the heavy covering of vegetation prevents the light from penetrating, and as a result there is often *not sufficient beneficial bacterial action* taking place in the soil.

Within these rainy tropical regions there is *little com-*

mercial agriculture except the cultivation of bananas, a plant which has many characteristics of the native vegetation. Nevertheless, it requires a considerable amount of attention to overcome the disadvantages of the rainy tropics. In most instances, the agriculture in these regions is a patch type. A clearing is made and the soil is cultivated, but generally it is abandoned in a short time for new land of virgin qualities as the soil will not stand successful cropping unless there is an addition of lime, organic matter and fertilizers.

Cold humid soils or podsols.—In the coniferous forest regions in central and northern North America and northern Eurasia occur the *infertile* podsols or cold-humid soils. They develop in the wet and cold climate where there are long winters and short summers. Their ashlike color has given these soils the Russian name podsols, the term " sola " meaning ashes. As poor soils they are deficient in humus and decidedly acid in reaction. In occupying areas where there is a prevalence of low temperature they are lacking in the essential soil organisms.

With proper methods of tillage the podsols have proven *suitable for specialties*, such as rye, barley and potatoes, crops which grow well in acid soils and mature in a short time. The production of potatoes in northern Maine is an excellent illustration of the importance of these soils for specialized farming. The growing of rye in Russia is another example of the human adjustment to environmental influences, as rye is a plant that can be successfully grown in a cold climate and on poor soils.

Warm-humid or subtropical soils or rederths.—In the middle latitudes bordering the tropics, where moderate rainfall prevails, is found a class of soils known as rederths, so-called because they are predominately red in color.

These warm-humid soils are as thoroughly leached as the laterites or podsols but they still fall short of being classed as fertile soils. Under good management the rederths have shown favorable results. The cotton of the United States, the coffee of Brazil and the tea of China are grown on these warm-humid soils. Even though the rederths are not highly productive under their natural conditions, they are nevertheless *favorably located* with respect to a suitable agricultural climate which adds to their economic importance.

Cool-humid soils or gray-brownerths.—In the cool-humid lands of northwestern Europe and northeastern United States are found the *best of the humid forest soils.* They have a moderate fertility and are suited for the growing of grain and hay crops. The presence of a long growing season and a short winter favors the utilization of these soils for productive agriculture. In most instances, these cool-humid soils have developed in deciduous forest areas where the topography is rough and hilly.

Other soil classes.—Mountain soils, tundra soils, and swamp soils may be recognized as soil complexities. The tundra soils have very little value on account of their unfavorable location with respect to climate. This may also apply to some mountain soils which may have not only a nonagricultural climatic environment but also extreme complexity in characteristics. Swamp or muck soils are found in rather limited areas without uniform distribution and they may be equally variable in their character.

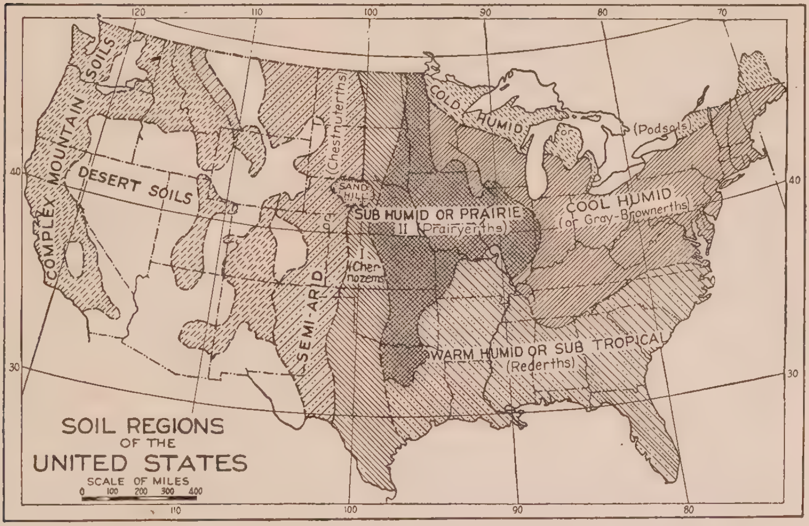

Fig 85.—The Major Soil Types and Regions of the United States.

An attempt to apply the foregoing classification to the regional distribution of the major soil types of the United States is made in the foregoing map. (See Fig. 85.)

Effect of biological elements on the utilization of land for agriculture.—In addition to locational factors, climatic factors, topographic factors, and soil factors, there are two other important groups of elements that are closely related to the utilization of land for agriculture; namely, plants and animals, and man and the works of man. The former group is briefly considered here.

Plants.—Probably, the most effective biological element entering into competition with agricultural uses of land is *the forest.* Much of the forest land can be used for agriculture; and, vice versa, nearly all of the agricultural land can be used for forests. The nature of the utilization of these competitive lands is generally determined by the principle of profit and loss. In the long run, the most successful type of land utilization will prevail, whether it is for forests, agriculture, or some other use. (See Fig. 86.)

Another way in which plants may affect the use of land for agriculture is through their harmful influence. *Weeds,* such as the Canada thistle and the quack grass may completely alter the type of agricultural practice and even entirely eliminate the possibilities of successful farming. Both of these obnoxious plants are prevalent in the Great Lakes region of the United States where, on conservative estimates, five million dollars annually are expended for their eradication. Farmers are sometimes forced to yield to the power of these harmful plants in either changing from crop farming to the grazing industry or completely abandoning the land so far as any form of agriculture is concerned.

Animal life.—The boll weevel, a destructive pest, has somewhat affected the utilization of land for cotton in the United States. The insect is said to have entered southern Texas from Mexico. Year after year the pest has spread north and east and as a result new land for the cultivation of cotton has been sought by the cotton grower. In 1916 the crop of Sea Island cotton in Georgia and Florida was about 117,000 bales while that of 1920 was less than 2,000 bales. In many districts the farmers stopped growing cotton and introduced a diversified type of agriculture which, in some respects, was a betterment for southern agriculture as it eliminated the speculative principle of a one-crop system.

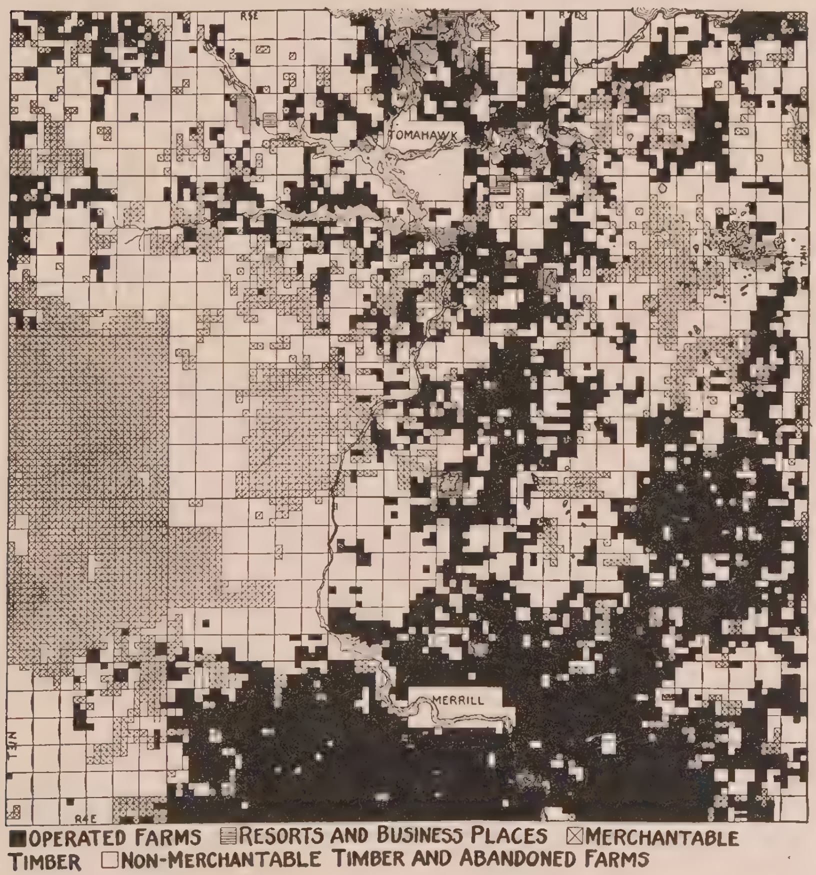
R5E
R7E
TOMAHAWK
MERRILL
R4E
■ OPERATED FARMS
▤ RESORTS AND BUSINESS PLACES
☒ MERCHANTABLE TIMBER
☐ NON-MERCHANTABLE TIMBER AND ABANDONED FARMS

Fig. 86.—Land utilization in Lincoln County, Wisconsin. The towns and resorts are in the vicinity of the main water bodies. Of the 2279 farms of the county, 402 or 17.6 per cent were abandoned.

In more recent years, the corn borer has been responsible for similar changes in the north. Land formerly used for the production of corn has been, in some cases, employed for the growing of wheat, oats, or other crops which the corn pest does not injure. The locust is another insect which has destroyed the fruits of some lands used for agriculture. Still more recently, the Mediterranean fruit fly has arrived to threaten agricultural prosperity in our southern states.

Social elements in agriculture.—Agriculture, like any other industry, includes two groups of factors: (1) the *physical* attributes or equipment, and (2) the *social* element or man. In order to manufacture or produce, these two groups must work together. In agriculture, the soil represents a sort of natural factory in which many forms of raw materials are converted into finished products. But, like all manufacturing plants, its usefulness and profits depend upon the ability and energy of the manager. One factor is useless without the other.

Man the active agent.—Thus, it is necessary for man in agriculture to select a soil or factory that is best suited for his purpose, for there are as many kinds of soils as there are different types of factories. Man would not attempt to manufacture shoes in a factory designed and equipped to produce automobiles. In the same manner, a skillful soil manager or farmer should not attempt to grow corn in soil best suited for the production of cranberries. Indeed, there are plants as well as soils which are so equipped that man can manufacture various commodities. For example, there are factories producing various kinds of hardware, as well as soils producing many varieties of plants: such as, wheat, corn, beans. Material and machinery, whether in the industrial plant designed by man or in the soil factory equipped largely by nature, require intelligence and experience. What to do after the factory is in operation, concerning the care of the machinery, the selection of raw material and many other essentials, must be understood in order to obtain successful results. Crops have failed, as manufacturing plants have gone into hands of receivers, because the manager did not have a thorough knowledge of his business.

The soil element needs management and conservation.—The future of agriculture depends largely upon the reciprocal relationship between man and soil. Since man is the intelligent and directive head in the partnership it falls upon him to select and manage his soil factory efficiently. The questions arise, however: Will this soil factory eventually wear out? Is the farmer going to be able to replace the necessary machinery if it gives way to destruction? Is he going to be able to supply the necessary raw materials? Whitney of the United States Department of Agriculture says:[8] "there are many reasons for believing, that the soil has regenerative power that will prolong its life indefinitely and that the ability to continue to produce crops is dependent solely upon the knowledge and skill of the man who works the soil."

This statement is in part substantiated by the older soils of Europe and Asia. The yield per acre is higher to-day than it was two hundred years ago, largely because of better agricultural technique. Even though the cultivated soils are tending toward poverty, although this is very likely not the case, the yield of agricultural products may be increased in the following ways:

1. More intensive cultivation.
2. More and better use of fertilizers.
3. More efficient soil management.
4. The prevention of soil erosion which, in the United States alone, annually removes two hundred million dollars worth of plant nutrients.
5. The selection of more suitable crops.
6. The improvement of plants.
7. The use of new land through reclamation of deserts by irrigation, swamps by drainage, lowlands by filling, and woodlands by deforestation.

Whether the production of food and other agricultural products will keep abreast of the increasing population is a matter of conjecture. There is reason, however, for believing that a supply to meet the future increased demand for agricultural products is assured through the expected progress in science and its application to agriculture, industry, transportation, and other forms of human activities.

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[8] Whitney, ''Soils and Civilization.''

CHAPTER XII

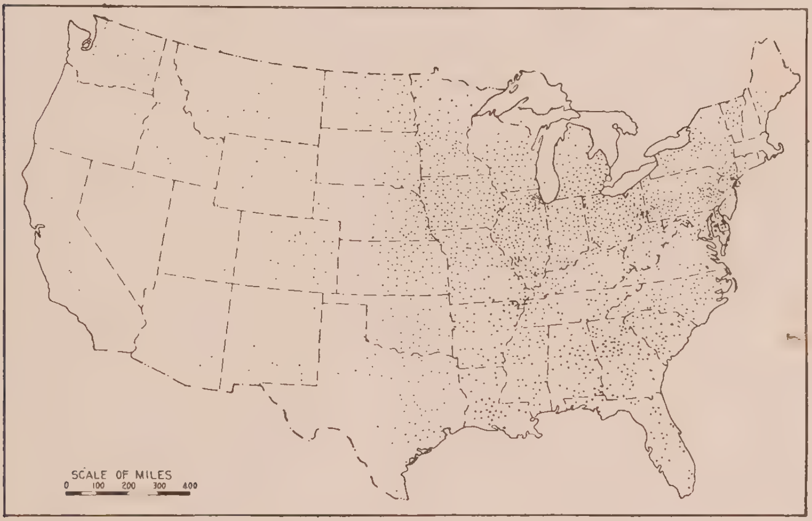
THE UTILIZATION OF URBAN LAND

Urbanization.

Urban geography.—One of the more recent developments in social geography has been the increasing attention given to urban geography as an important phase of regional geography. The subject includes such topics as the location of cities, their size, growth, and functions; the density of population of cities, and their relation to the hinterland, or surrounding country, upon which they largely depend for their food supplies, raw materials for their industries, and customers for their products. No phase of urban geography, however, is of more importance than that of urban land utilization.

Relation to land utilization in general.—To many people, perhaps, land problems and land policies seem connected only with agricultural land. And of course the use of land for agriculture requires a larger area than any other use. So, too, in the United States, agriculture is the largest industry considered from the point of view of the value of the product. Perhaps the most significant thing about that, though, in our national life is the fact that agricultural land furnishes nearly all the food on which the city population lives. The great improvements in the utilization of agricultural land since the days of Malthus have helped make possible the great increase in city population since then. The great growth of cities in recent times makes urban land increasingly important in modern life, but its utilization must be considered in connection with the utilization of other classes of land. From them it gets its increases in area, and from them come the food and raw materials needed by the city population. A proper balance between the city population and the food supply is necessary to national well-being.

The growth of cities.—One of the most striking facts of modern society is the tremendous growth of great cities. This concentration of population is called *urbanization.* And it is this fact which accounts for and gives character to urban land, and which is at the basis of the many problems of urban land utilization. Today more than half the population of the United States lives in cities, and in large towns of not less than 2500 people. Only as recently as 1890 the rural population, that is, the people living in the country and in villages and towns of less than 2500, constituted about 65% of our total population, as compared with 35% in cities. By 1900 the urban population had increased to 40% of the total, but the rural was still 60%. In 1910 the proportions were 54.2% rural and 45.8% urban; but sometime during the following decade the urban passed the rural population, the census of 1920 for the first time showing that more than half the total was urban, the percentages being 48.6% rural and 51.4% urban. That is, in the continental United States, out of a total population of 105,710,620 in 1920, the urban population was 54,304,603 as compared with but 51,406,017 rural. Even these figures,



From map in Yearbook of U. S. Dept. of Agr., 1921.

Fig. 87.—Population of the United States in Incorporated Towns under 2500 in 1920. (Each dot represents 4000 people.)

however, do not tell the whole story, for many of the people whom the census classes as rural live in villages. (Fig. 87.)

From the census of 1920 to that of 1925, there was a decrease of 13,000,000 acres in our crop land—the first decrease ever shown by census statistics in the farm area of the nation. There occurred also a decrease of farm population. Hence by 1925 it was estimated that approximately 30,000,000 on the farms of the United States had to feed and clothe probably 85,000,000 people, the latter group, however, constituting the greatest and wealthiest aggregation of consumers on the globe.

Close relation of city and country.—The fact that this great urban population constitutes the market for the products of the rural lands is only one side of the picture. On the other, is the equally important fact that the city population is dependent upon the products of farm, forest, and mineral lands for practically all the basic elements of their food, clothing, shelter, and raw materials. The city is not self-sufficient. Cut it off from communication with the country, and any large city will very soon experience food shortage and physical distress.

Another aspect of the close interdependence of urban and rural lands, which should not be overlooked, is the large sale of city-made goods to the people of the rural districts. Cut down the buying power of the agricultural population by a billion dollars a year, as sometimes happens in a period of severe farm depression, and it is not long until urban manufacturers of farm machinery, automobiles, and other merchandise, find their sales falling off and their profits dwindling. As a result they begin to slow down production, by turning off some of their employees, running only part time, or even closing down for a time. Laborers out of work can not pay grocery bills so promptly, nor buy so many other things the city business man has for sale. Wholesalers of groceries, dry goods, furniture, etc., also find their orders from rural retailers falling off and their collections harder to make. The people of both urban and rural lands should keep in mind that the well-being of each is closely related to the prosperity of the other.

Most of urban population in large cities.—Not only has the urban population of the United States grown much faster than the rural; but it is interesting to note that if we divide the cities into two classes, one consisting of those cities having less than 50,000 people each, and the other of those with more than 50,000; we find that the latter group, including 144 cities in 1920, contained 60.2% of the whole urban population of the nation, as against but 39.8% in the smaller cities, although there were 2643 of the cities less than 50,000 in size.

Urbanization in other countries.—This concentration of population in cities is noticeable in certain other countries. *France* is not so highly urbanized as the United States, as less than half its population (44.2 % in 1911) live in cities of 2000 or over. Yet there, too, the larger cities, though fewer in number have grown faster and contain most of the urban population. Thus in 1911, the cities of France less than 20,000 in size contained 18% of the total, while those of 20,000 and over included 26.2% of the population of the nation. That France's urban population is less than half the nation's total is probably due to her declining rural population, there being no surplus in the country to migrate to the city. This is offset to some extent, however, by the steady increase in the number of foreigners who reside more or less permanently in France. These foreigners, largely Americans, made up more than one-third of the net increase for the whole of France during the period from 1906 to 1911. Of all the French cities or classes of cities, Paris grew the most rapidly.

In *Germany,* from 1882 to 1910, the rural population remained almost stationary, while the urban population greatly increased, growing from 41.8% of the total in 1882 to 60% in 1910. The greatest increase occurred in the groups of cities over 100,000; while the small cities showed hardly any gain. As in France, the smaller cities declined in relative urban importance seemingly in sympathy with the closely related rural population.

Probably the best example of an advanced stage of urbanization in the world today is that of *England and Wales.* Over 50% of their population was urban 75 years ago, about the situation in the United States in 1921. While in 1911 their urban population was 78.1% of the total. As in the United States, the larger groups of cities seem to be growing more rapidly. In 1911, the cities less that 20,000 in size had 17.5% of the total population of England and Wales; those from 20,000 to 100,000 had 22.7%; and the group of 1000 and over had 37.9%.

Scotland is also highly urbanized, its urban population in 1911 being 75.4 of its total population. The topography of the country, being rugged with little arable land, is better suited to industry and urbanization than to farming. Glasgow has had the greatest growth. It has a favorable commercial location as a port, is in the midst of a great coal and iron district, and has a climate well suited to the textile industry. In contrast to Scotland, Ireland is less industrialized and less urbanized. In 1911 only 33.5% of its population lived in cities over 2,000. *Ireland's* total population declined steadily from 1841 to 1911; but it was the rural population that declined, as the urban population showed an increase chiefly, however, in the great cities of Dublin, a manufacturing and commercial city; and Belfast, the great center of linen manufacture.

Industrialization and urbanization.—Along with the growth of urbanization, as illustrated in the foregoing paragraphs, there has also occurred a growing industrialization; which indicates that industrialization is perhaps *the most important factor in modern urbanization.* In the United States, the cities predominantly commercial are fairly well distributed over the country serving the demands for food and merchandise of all regions. But the manufacturing cities are nearly all concentrated in the New England, Middle Atlantic, and East North Central States. In fact in 1920, west of the Mississippi River, Kansas City, Kansas, was the only city with over 100,000 population that was predominantly industrial.

While for the United States as a whole, 51.4% of the population in 1920 lived in cities, this percentage did not hold for all geographical sections alike. As a matter of fact, only *four of these sections had more than half of their population* *urban,* as may be seen from the following:

PERCENTAGES OF URBAN AND TOTAL POPULATION OF THE UNITED STATES BY GEOGRAPHICAL DIVISIONS IN 1920

	Percentage of Their Total Urban Population	Percentage of the Total Urban Population of the United States in This Section
New England	79.2	10.8
Middle Atlantic	74.9	30.7
Pacific	62.4	6.4
East North Central	60.8	24.0
West North Central	37.7	8.7
Mountain	36.4	2.2
South Atlantic	31.0	8.0
West South Central	29.0	5.5
East South Central	22.4	3.7

Of the 4 sections shown above to be over 50% urbanized, one, the *Pacific,* owes its urbanization largely to commercial factors, having 6 predominantly commercial cities of over 100,000 population. The other three sections with more than 50% of their people in cities, not only *contain* 65.5% *of the whole urban population* of the United States, but include 31 of the nation's 32 predominantly industrial cities of over 100,000 people.[1] Increasing industrialization is thus indicated as a most important influence in the urbanization of the United States. (See Fig. 88.)

A suggestive geographical relationship, in the location of the *industrial cities* of all sizes, is the fact that they are found *chiefly in groups* and usually on *or along some body of water.* Thus of some 375 cities of the manufacturing belt of the United States, not less than 300 are situated along some water line. More than 50 of these are on the shore of the Atlantic or of the southern Great Lakes; over 200 are on rivers; and some 30 on canal sites. This shore line, or valley location, of these cities contributes to the usually elongated shape of the groups in which they are found.

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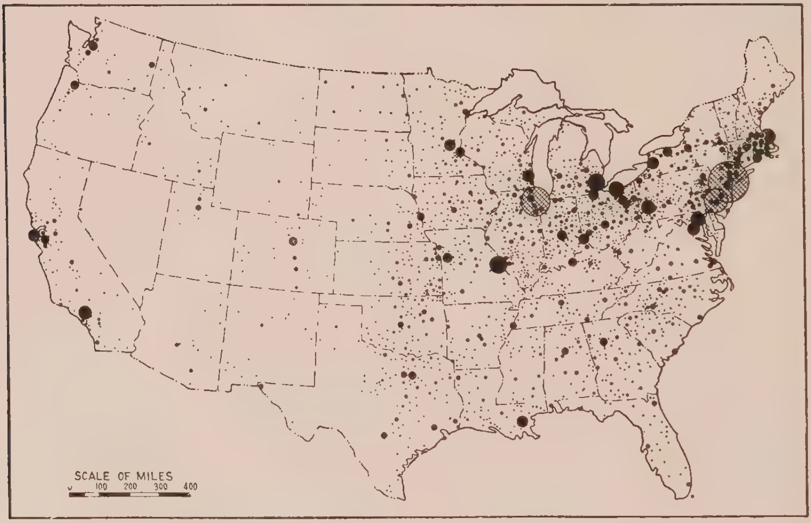
[1] When we consider individual states, the figures are startling in some cases. Thus, the population of Rhode Island and Massachusetts is nearly all urban; that of New York and New Jersey is over three-fourths urban; California and Illinois more than two-thirds; and Ohio and Pennsylvania over five-eighths urban.—*U. S. Census,* 1920, Vol. I, Population.

Urban groups.—The grouping or clustering of smaller cities *about some central city* on which they are more or less dependent is a striking feature of modern urbanization. Thus, around or within 150 miles of New York City are 7 such cities each over 100,000 in population; namely, Newark, Jersey City, Paterson, Bridgeport, New Haven, Yonkers, and Albany. In a similar way, around Boston are grouped Cambridge, Fall River, Lowell, Hartford, New Bedford, Springfield, Providence, and Worcester. Likewise, Philadelphia is a nucleus for Camden, Reading, Trenton, and Wilmington. (See Fig. 89.)



From Yearbook of U. S. Dept. of Agr., 1921.

Fig. 88.—Population of the United States in cities of 2500 and over, 1920 (Towns from 2500 to 10,000 are shown by the smallest size dots, larger cities by circles of varying size.)

As a general rule, the *subsidiary cities* possess a relatively high degree of specialization and a high degree of industrialization. The great city often contains the central controlling office of an industry, the actual factories of which are in other cities.

Thus in 1919, of the 314 large central offices each controlling ten or more establishments, 183, or 62.7% were located in the twelve cities of 500,000 or more population. In the same year, of the 792 central offices each controlling three, four or five establishments, 300 were located in these same twelve cities. Of the 2776

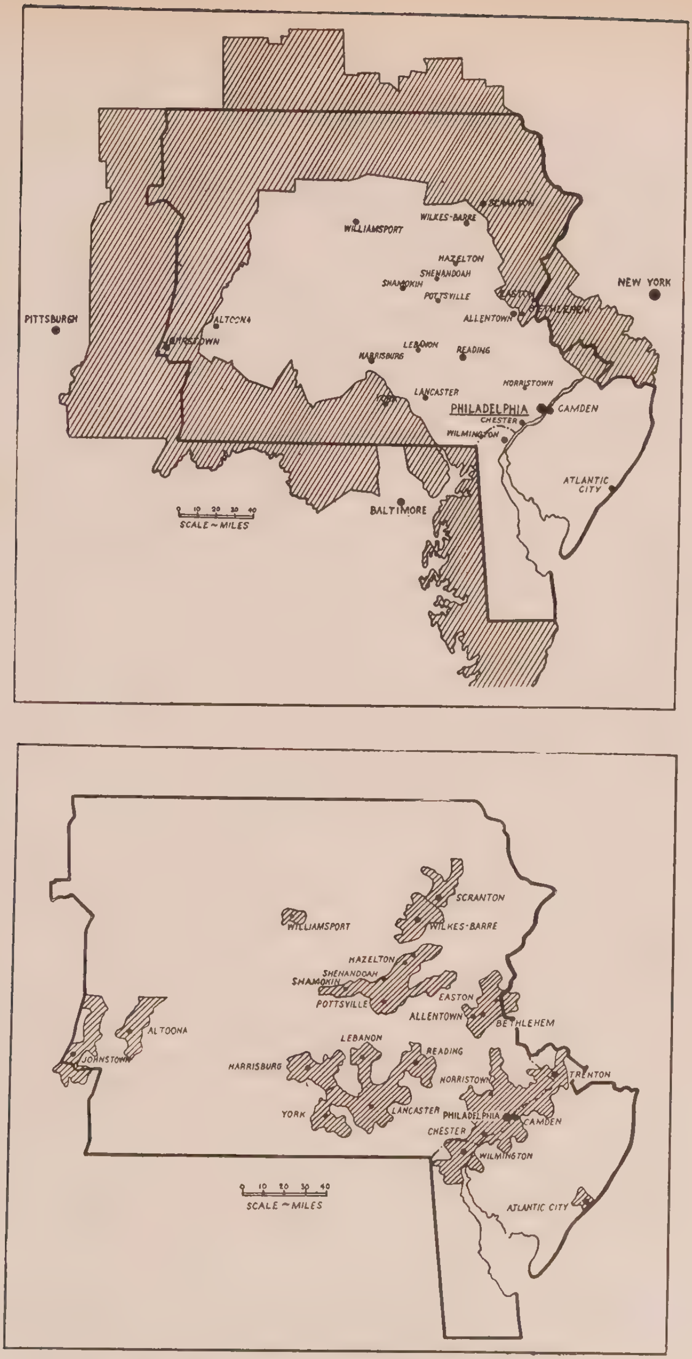


Fig. 89.—The Philadelphia Marketing Area.

Upper.—Shaded area is the zone of active competition.

Lower.—In shaded areas around cities the density of population is 150 or more per square mile. (From Dewhurst: Commercial Survey of the Philadelphia Marketing Area. U.S. Dept. of Commerce.)

establishments controlled by these 792 central offices, 863 were located less than 5 miles away from the central office, 1099 from 10 to 100 miles away and 814 more than 100 miles away. Approximately 70% of the establishments were located within 100 miles of the central office, or within the radius of the nuclear formation of the focal city.[2]

That this clustering of large cities around a central city is not yet found farther west is due partly to the fact that there the large cities are mostly commercial, distributing centers for agricultural regions; and partly that, being younger than the eastern cities, they have not yet had time for this development. The latter is the chief reason in the case of Cleveland, Detroit, and Chicago. Clusters chiefly commercial are beginning to form about the larger southern and western cities; as for example, about Kansas City, Mo., and San Francisco.

Summary.—The more rapid growth of urban than rural population; the tendency of the larger city groups to grow faster than the smaller ones; the change of the nation from a predominantly agricultural country to an industrial nation, with the resulting concentration of city populations, expansion of city areas, and grouping of satellite urban communities around the great central cities; all indicate the growing importance of urban land and the increasing problems of its utilization.

Characteristics of Urban Land.

Urban locations.—As in the case of other natural resourses, land is continually being shifted from one use to another, in response to changing human wants. The first thing to separate urban land from other uses is the choosing of the site for the city. The chief reasons why men have located cities where they are, may be classed according to the motives: (1) defense, (2) religion, (3) government, (4) commerce and industry, and (5) health and recreation.

Thus, Paris built on a group of islands in the Seine River, and Quebec on a high bluff above the St. Lawrence were easily defended. Jerusalem may be classed as a religious center. Washington, D. C., midway between New England and the South, and Columbus in the center of Ohio were selected as capitals.

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[2] Dorau and Hinman, "Urban Land Economics," p. 110.

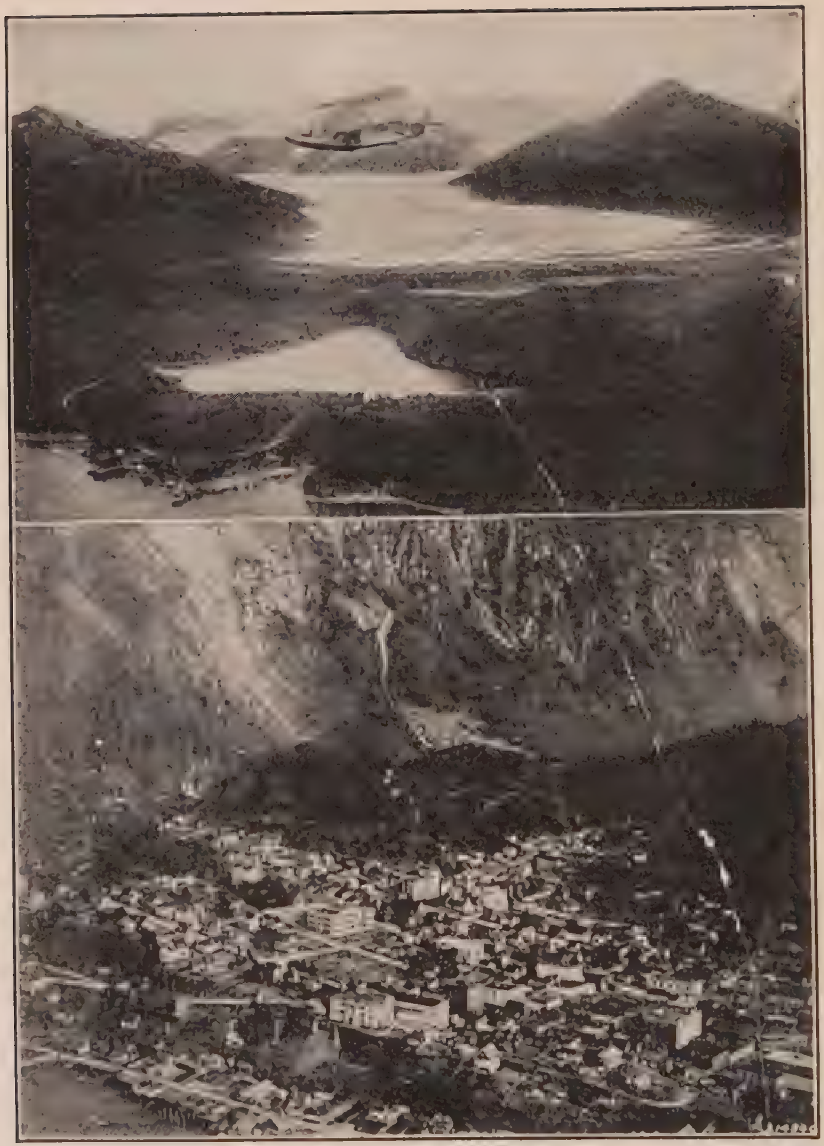
Gary, Indiana, intended for iron and steel manufacturing, was located near the southern end of Lake Michigan, not far from Chicago and the center of population of the United States, and on important east and west railroad lines. Here we see the influence of accessibility of raw materials, labor, capital, and markets.

New York on the Atlantic, at the mouth of the Hudson with an excellent harbor and hinterland (tributary trade area); and London, England, with its great hinterland and fine water communications down the Thames to the North Sea; the Rhine River, the English Channel, or the Atlantic Ocean, were trade centers from the beginning and still maintain world commercial supremacy. Chicago, Philadelphia, Detroit, Cleveland, and St. Louis, all with water communications, are other examples of commercial locations.

Hot Springs, Ark., with its mountains and mineral waters, is a noted health resort; and Long Beach, Cal., and Miami, Fla., each with advantages of ocean, beach, and climate, illustrate cities located for pleasure and recreation.

Peculiarities of urban land.—The *location* of the land on which a city is built is thus seen to be of primary importance. This peculiar importance of location is equally marked when one considers the different areas or lots within the limits of the individual city. This is readily seen, for example, when one notes the different land values or rental prices in different parts of the town. A difference of a few hundred feet in the location of a lot may make a difference of four or five hundred dollars a front foot in its price. A corner lot, past which twice as many people may go, as go past a lot in the middle of the same block, may on account of these additional possible customers be valued anywhere from 50 to 75% higher.

A half block in the Chicago loop district, the chief business center, was recently sold for the reported price of $4,000,000, the plan being to erect on it a 41 story building. Such high



Photos by courtesy of U. S. Forest Service.

Fig. 90.—A City in the Land of Glaciers, Gold, Fishcanneries, and Forests.

Upper.—Mendenhall Glacier, near Juneau, Alaska. Tongass National Forest in the foreground.

Lower.—Juneau, the capital of Alaska, situated at the base of a mountain wall, near the northern end of the sheltered inside water passageway followed by the boats from Seattle.

values, of course, make necessary a highly intensive use of the land. As *land area* is so *expensive* in the central business district of a city, the tendency is to go up, or down; for example, to erect skyscrapers or build subways. The Woolworth building in New York, an island city naturally of limited area, is 792 feet high, the Chrysler building on 42nd Street is 809 feet, and now (April, 1929) it is proposed to erect the new Bank of Manhattan Building on Wall Street to a height of 840 feet, the world's tallest building. Area is not so much a limiting factor for business management of urban land as it is in the case of farm land. A given amount of money will acquire a much smaller and, so, more easily managed area of city land than it would of farm land. (See Fig. 138.)

Urban land is peculiarly *dependent on transportation,* which both causes and relieves congestion of people. In the central business district, with proximity, or accessibility, to all parts of the area, more business can be transacted in a given time with savings in transportation costs, hence high land values and high rents are the rule. Thus only business activities that can stand high rents tend to locate in such a district. Others tend to go farther out where land values and rents are lower, but where longer transportation distances and time consumed add to costs of doing business. Thousands of workers in New York City spend time and money on ferry, tunnel, and subway, going back and forth to New Jersey, Long Island, or up the Hudson to suburban lands where residence costs are not so prohibitive. The group of financial interests in Wall Street does not deal much in small transactions, but is concerned chiefly with matters of such high value that it can afford to outbid all others for the accessible central location it wants.

Another peculiarity of urban land is the *great risk and uncertainty* attending its utilization Urban life to-day is very dynamic; rapid changes take place. As seen in the chapter on forest land utilization, towns often spring up, flourish for a time, and then decline. Within a city, land frequently changes from one use to another. A residential section may change to a business district; a manufacturing section may expand; or different racial elements may invade a residential district. A new residential section may be built up ahead of demand, and the houses in it may sell or rent quickly, while many in an older section become vacant and decline in value. Then too, public policy as to land utilization often changes. Zoning laws endeavor to remedy the evils that often result from letting the city grow without restrictions as to the character and use of each district. More than half the city population of the United States is now under some form of the zoning system.

Physical characteristics.—Urban land has two important physical characteristics: (1) indestructibility, and (2) immobility. Fertility of course is not of great importance in most urban land. In the parks and in the landscaped lawns of residential districts it has some place. In some of the cities, even vegetable gardens still exist. Thus, in the cities of Australia and New Zealand, where the extremes of wealth and poverty are not yet so evident, the typical bungalows of clerical and other employees may be seen in the midst of a well-cared-for lot with a flower garden in front and a vegetable garden at the back. In New York, however, it would hardly be considered an economical utilization of urban land to have a lot on Times Square planted in potatoes.

Farm and forest land may be exhausted and mineral land may be practically destroyed as far as its service is concerned, but urban land being primarily used for building sites or for standing room, gives the best example of *indestructibility of its services.*

As to *immobility,* urban land, like any other land, has both extent and substance, and of course some of the substance may be removed and transported, but from the point of view of extent and physical location, urban land may be said to possess immobility. The real estate man, for example, who looks upon land as a commodity which he buys and sells, cannot pick it up and send it over to some other place, as a grocer can a sack of sugar. Even here, however, the case is more relative than absolute. The desirability of a lot's location, for example, may be very much altered by a change in transportation facilities, or by the improvement of near-by districts.

The city of Chicago is engaged, at a cost of $75,000,000, in reclaiming from Lake Michigan some 15 priceless fathoms, which will provide perhaps the greatest water front development in the world. Millions of tons of sand and rocks have already gone into the project and millions more will be used. Already 630 acres of land have been so reclaimed, and in the end it is expected to stretch for six miles along the shore, flanked by the towering skyscrapers of Michigan Boulevard on one side, and on the other by the broad expanse of the lake.

Another physical characteristic of urban land, a consequence of its immobility, is the fact that *no two pieces are exactly alike.* As a result of its fixed location, it is always a particular piece of urban land that is bought or sold. The realtor is unable to substitute or engage in " short " selling, as is often done in the case of other goods like wheat or stocks and bonds. *Topography* is a physical condition that also makes one piece of urban land differ from another. Topography, however, can be and often is changed somewhat. Thus, lots are commonly leveled or filled, but general elevation is almost as fixed as physical location. The character of the soil and underlying rock, too, often affect the utilization of urban land. Then there is that which is of much importance, particularly to residential land; the matter of exposure to plenty of fresh air and sunshine and the outlook over a body of water or beautiful scenery. Again, however, *environmental determinism is not indicated.* None of these physical characteristics determines the quality of the location. It depends, after all, on the relative importance attached to the various advantages of each piece of land by competing buyers or utilizers.

The Classification of Urban Land.

The structure of cities.—In ancient and medieval times, the cities built for protection were generally fortified by walls, which naturally fixed the outline and plan of the city and limited its expansion. The American tourist who visits the old

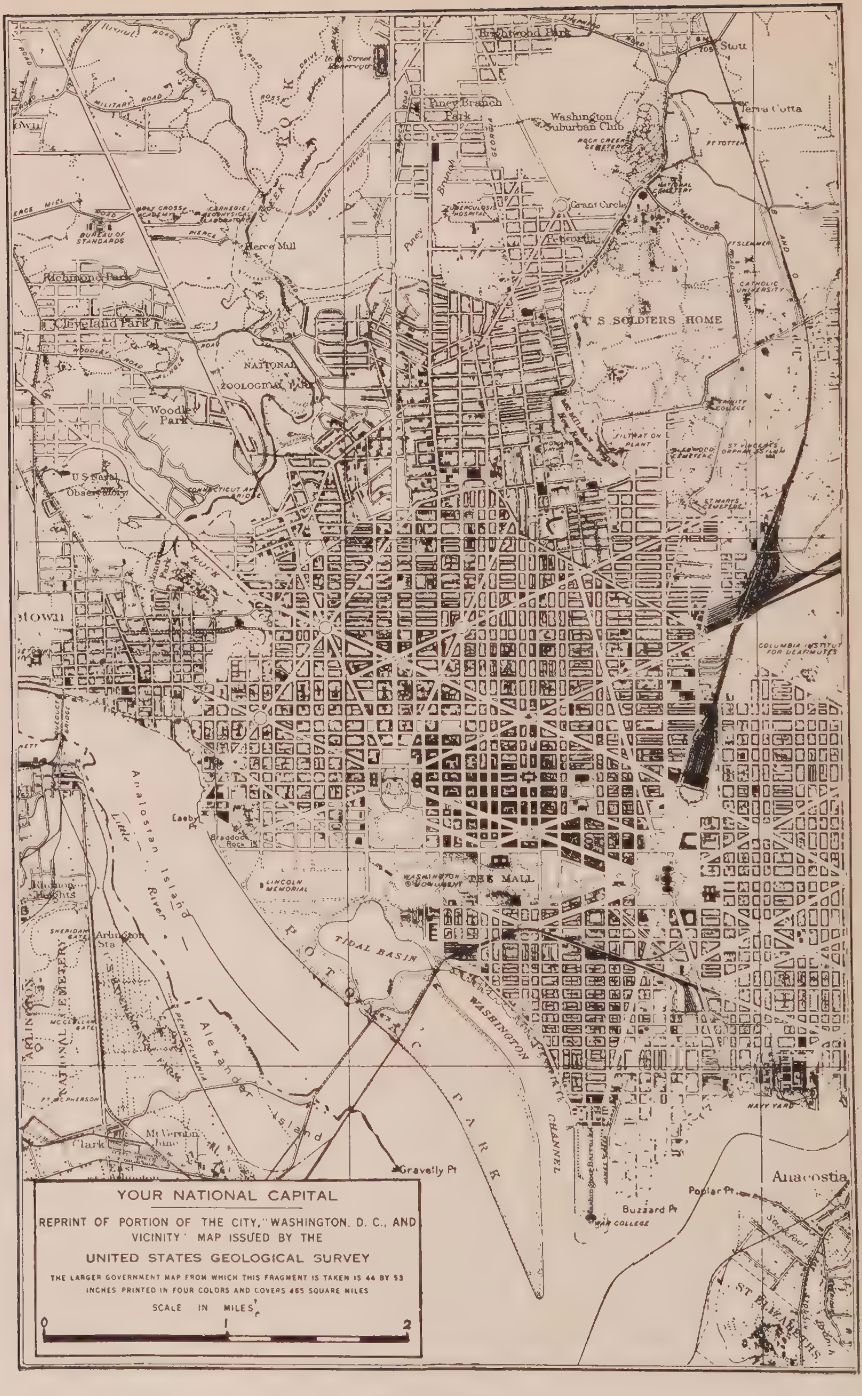
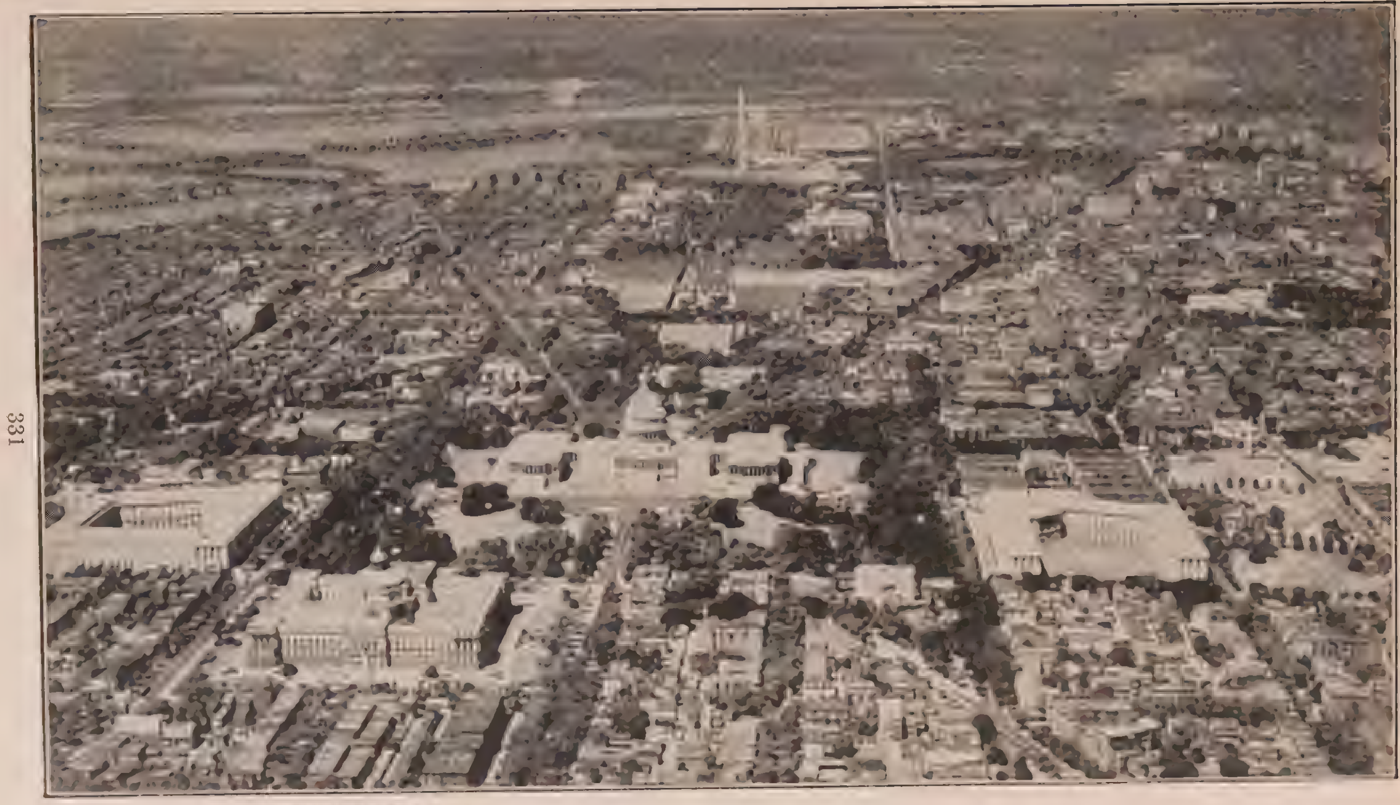


Fig. 91.—Plan of Washington, D. C.



By Courtesy of A. E. Nesbitt, Fairchild Aerial Surveys.

Fig. 92.—Airplane View of the Capitol and the Mall, Washington, D. C.

town of York, England, is at once interested in viewing the ancient city walls with their ramparts.

Cities erected for religious purposes, generally, as in the case of Athens, Greece, had a *centrally located temple* around which were the houses of the priests and the royal palaces. Modern Rome still portrays somewhat this structure; as the great church of St. Peter's with its impressive dome and basilica, and near-by Vatican, the home of the Pope. In a similar way, capital cities tend to grow up around the capitol and other public buildings, as may be seen in the case of Washington, D. C., or Columbus, Ohio.

Most modern cities, however, are constructed along the lines of *economic utility,* commerce and industry being the leading factors in city building today.

Many cities have grown up from villages, which were originally rather compact in shape if centered about a fort for defense, or somewhat star-shaped if spread out from a crossing of roads or other lines of transportation. *Topographical and hydrographical factors* often influence the external structure of the city. Thus, cities like Cleveland, Chicago, Philadelphia, and New York, which grow up on lakes, rivers, and harbors, have water fronts as the basis of their street plan. Inland cities based on highways commonly have a rectangular system, but old trails and stage routes frequently determined the important street lines. Boston may be cited as a classic example of a city with an old center of crooked streets and a surrounding modern area with the rectangular system.

The *distribution of the land within the urban area* usually depends upon the various uses which the urban land serves or is expected to yield in the future. Some of the land within the city is usually not yet utilized; perhaps some is economically not usable. The functions of city planning commissions and of zoning systems are to apportion the urban land among its various uses to the best advantage.

The uses of urban land.—These are classified by Professors Dorau and Hinman of Northwestern University as follows: [3]

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[3] "Urban Land Economics," p. 65.

A. Avenues of transport:
    1. Streets.
    2. Waterways.
    3. Railways.

B. Sites:
    1. Residential.
    2. Commercial.
    3. Industrial.
    4. Public and quasi-public building.
    5. Recreational.

Navigable waterways favor commerce, hence docks and warehouses are located there. Valleys and other low land tend to be used by railways. The situation of railroads and depots in a city influences the location of residential, commercial, and industrial districts. Regions of natural beauty, either from elevation or outlook, attract the best residences. Second-class residential sites are likely to be somewhat near the first; while the poorest class residential district tends to be near the railways or factories, or between the better residential districts and the central business area.

Retail sections tend to be on level ground at traffic centers. Wholesalers of heavy commodities are apt to be located near transportation lines or terminals, while those selling articles of small bulk but of considerable value prefer to be near their market, the retail section. Financial and office buildings tend to be near banks which may be a block or more away from the streets with heavy retail traffic.

Manufacturing of heavy goods is usually located where railroads or switches are available and on cheaper land at a distance from the business center of the city. Manufacturers of light articles probably will seek locations nearer the wholesalers and retailers. Accessibility to a supply of labor is always essential to manufacturing.

Recreational uses of city land include parks, playgrounds, beaches, and such private enterprises as theaters and dancing pavilions. Parks utilize woodland areas, ravines, and shore lines. Theaters are usually near hotels and traffic centers, movies particularly preferring nearness to retail shopping centers. Public and quasi-public buildings include government buildings, schools, churches, hospitals, libraries, etc., the locations of which vary with the nature of the services rendered. (Fig. 95.)

Influences on the city's expansion.—The direction in which a city grows is influenced by many factors. Dorau and Hinman enumerate six: [4] (1) physiography, (2) avenues of transport, (3) movement of districts, (4) nuisances, (5) private restrictions, and (6) public control. Usually a city grows along the lines of least resistance; therefore, in its early stages, the physical features of topography or water are followed where favorable. As population increases the demand for land, some physiographic factors, as hills, rough land, swamps, lakes, or streams, tending to prevent progress in certain directions, have to be modified, eliminated, or avoided at much expense. As

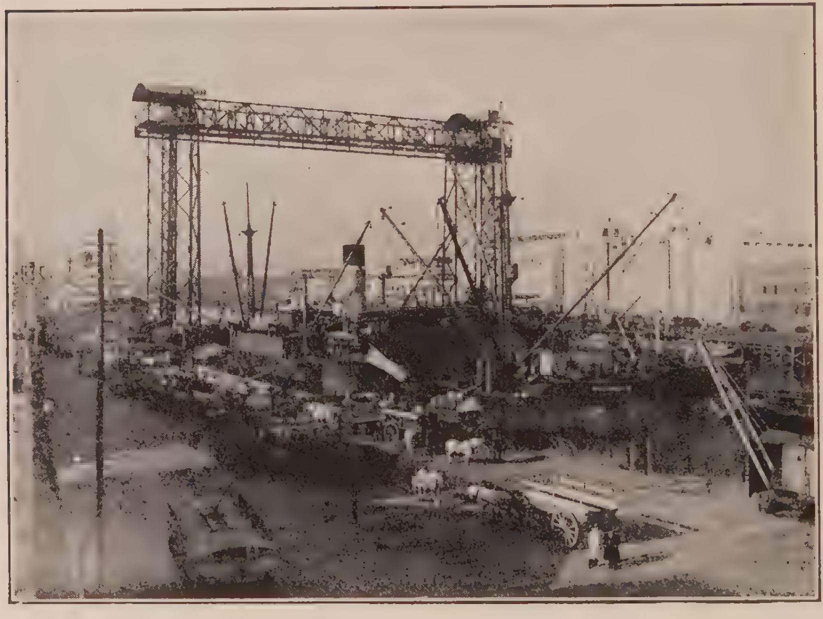

Photo by courtesy U. S. Shipping Board.

Fig. 93.—United States Vessel Discharging at Buenos Aires.

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[4] *Ibid.*, p. 76.

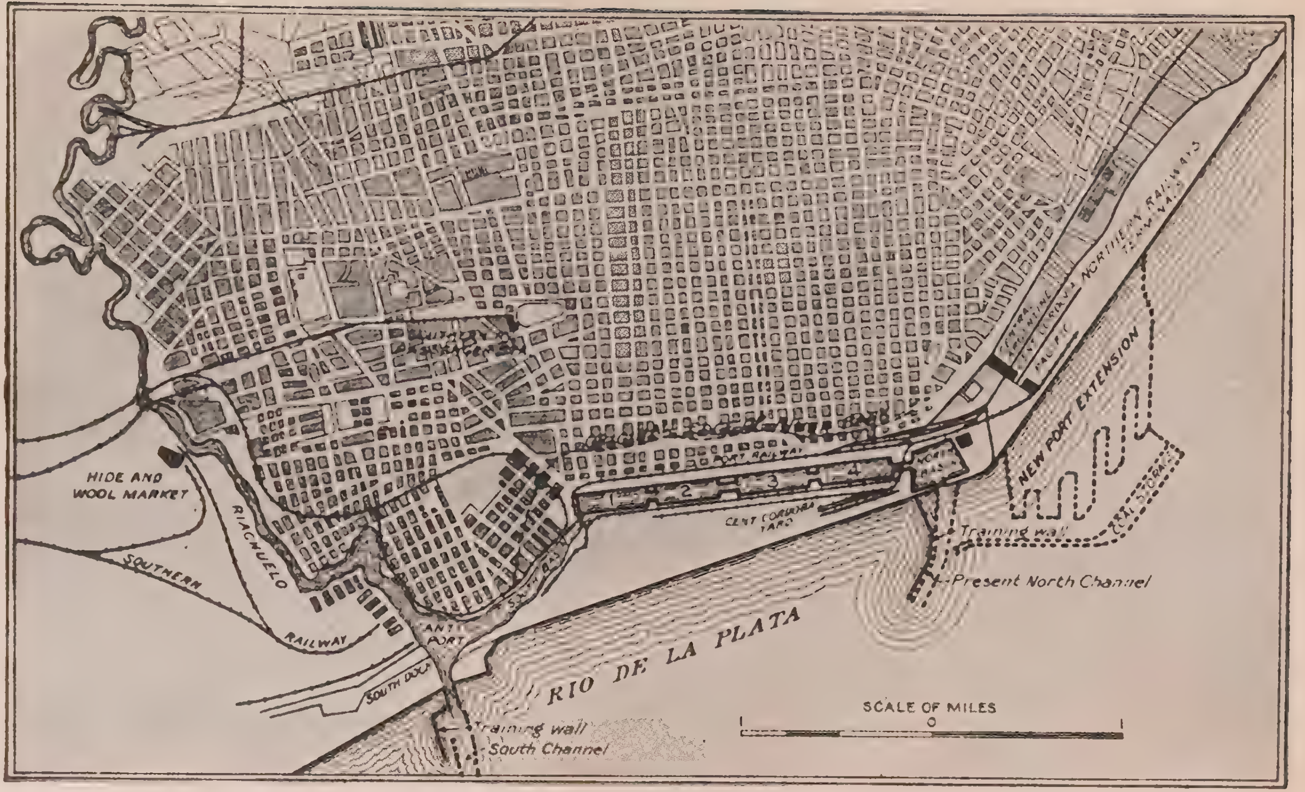

Fig. 94.—Port and Part of the City of Buenos Aires, a City of 2,500,000 at Junction of Two Rivers.

the city becomes larger, higher prices of land make possible the spending of more money to overcome physical obstacles.

The location of cities at junctions of lines of transportation is illustrated in many cases: river junctions, as Pittsburgh; a river and a lake, as Chicago and Cleveland; or river and highway, as Columbus, Ohio, where the national road crosses the Scioto River. The direction of growth is then generally along the lines of transport, with a tendency to fill in the angles more solidly later. As a business district crowds upon a good residential district, the latter tends to move farther out to a desirable physical location, and this movement is likely to be followed in direction by the other districts. The rise of the automobile has favored this tendency for residential districts to move to suburban sections.

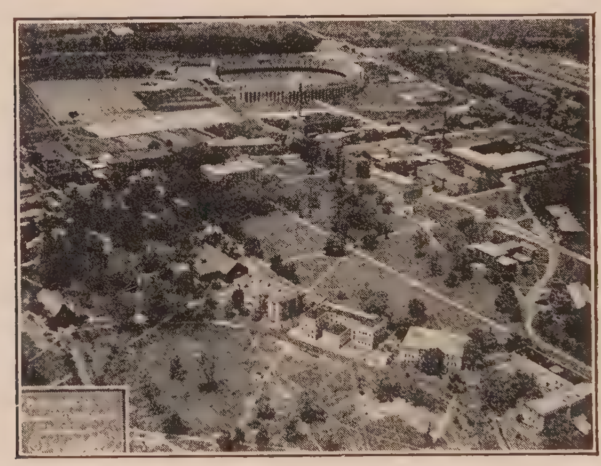

Fig. 95.—Airplane view of portion of campus of the Ohio State University, Columbus, Ohio. Surrounded by the city on three sides, the grounds slope westward to the Olentangy River, in whose valley are the stadium and athletic field, and beyond which is the university farm.

Density of population of urban lands.—The great growth of the urban population, in modern times, is even more striking in comparison with the rural population in its effect on the relative density of population. Statistics of urban areas are not very complete, but in 1920 the United States cities of 50,000 and over, for example, occupied only 4307 square miles of land out of our total area of over 3 million square miles, that is, nearly 33 million people or 3/10 of our population on about 1/700 of our land.

The United States Census in 1920 gave figures for 29 "metropolitan districts," that is, large cities including suburban territory. In these districts, 29,238,582 people occupied 6,816,110 acres of land; while in the 29 central cities alone there were 22,111,380 people on 1,518,715 acres.[5] This means that in these 29 cities there were between 14 and 15 people to every acre of land; whereas, for the United States as a whole, there were 18 acres of land to every man, woman, or child.

Putting the density of population in terms of square miles of land, that of the Continental United States in 1920 was 35.5; while that of our cities of 30,000 and over was 7222; and that of the cities over 500,000 in size was 11,718 people to the square mile.

That this great density of population in big cities is, even to a greater extent, also true of other countries is shown by the following table from Dorau and Hinman.[6]

DENSITY OF POPULATION OF WORLD'S LARGEST CITIES

CITY	YEAR	AREA (SQUARE MILE)	POPULATION	POPULATION (PER SQUARE MILE)
Chicago	1923	195	2,886,971	14,805
Philadelphia	1923	128	1,922,788	15,018
New York	1923	299	5,927,625	19,825
Moscow	1902	32	1,092,360	34,472
Glasgow	1921	30	1,034,174	34,472
London	1921	117	4,484,523	38,329
Tokyo	1905	30	1,969,833	65,661
Berlin	1905	29	2,033,900	70,135
Paris	1921	30	2,856,986	95,233

Distribution of city land among uses.—Most cities do not know how much of their land is devoted to different purposes, but the following figures from the city planning commission of Minneapolis, Minn., 1923, are suggestive.

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[5] *U. S. Census,* 1920, Vol. I. "Population," p. 63.

[6] "Urban Land Economics," p. 100.

URBAN LAND UTILIZATION IN MINNEAPOLIS, MINN., 1923[7]

	Per Cent of Total Area
Total area in the city 34,106 acres	
Publicly utilized land	**32.3%**
Schools	1.1
Parks	10.9
Streets and alleys	**20.3**
Privately utilized land	**45.9**
Residential	**36.2**
Single family	33.9
Duplex	1.5
4-flats	0.43
Apartment	0.37
Commercial	**1.6**
Industrial	**7.1**
Light industry	1.4
Heavy industry	**5.7**
Unutilized land	**22.8**
Vacant area	17.8
Open area	5.0

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[7] Ely and Morehouse, "Elements of Land Economics," p. 84.

Chapter XIII

MINERALS AND INDUSTRIES

Classification and Origin of Minerals.

Water and soil as minerals.—An old classification of the various earthly things which we find in our surroundings divided them among the animal, vegetable, and mineral kingdoms. As water is neither plant nor animal it naturally would be classed as a mineral. And, as a matter of fact, water must be considered as one of our most important mineral resources. It is on account of this very importance, however, that we have treated water in environment as a separate factor. In the same way, soils are for the most part mineral matter but as an element in the environment they constitute a distinct geographical factor.

Mineral elements.—The outer layer (about 10 miles thick) of the solid substance of the earth (lithosphere) is, according to F. W. Clarke, made up chiefly of 8 chemical elements:[1]

Oxygen	47.33%
Silicon	27.74
Aluminum	7.85
Iron	4.50
Calcium	3.47
Magnesium	2.24
Sodium	2.46
Potassium	2.46
	98.05%

This leaves less than 2% for all the other elements combined, and no one of these is estimated to exist in quantities over ⅖ of 1%. Minerals hardly ever exist as single elements. They usually are combinations of two or more elements, thus common salt (NaCl) is a chemical combination of Sodium and Chlorine, and water (H_2O) is made up of Hydrogen and Oxygen. As compared with the common rock minerals, the most of the mineral resources commercially important, as iron, coal, petroleum, gas, copper, and gold, are present in relatively very small quantities.[2] Of the common rocks and minerals that make up by far the largest bulk of the earth's crust, usually only a few would be mentioned (including water and soil) in an ordinary table of mineral resources.

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[1] “Data of Geo-chemistry,” Bull. 695, p. 35. *U. S. Geol. Survey,* 1920.

Classification of minerals.—Minerals may be classified in various ways; as, according to geological origin, form and structure, mineralogical composition, use, geographical distribution, or commercial importance. Van Hise divided them into these divisions, thus:

CLASSIFICATION OF MINERAL RESOURCES[3]

- I. Mineral Fuels.
    - A. Coal.
    - B. Peat.
    - C. Petroleum.
    - D. Natural gas.
- II. Metallic Resources.
    - A. Important Metals: Iron, copper, lead, zinc, gold, and silver.
    - B. Subordinate Metals: Aluminum, manganese, chromium, nickel, cobalt, tin, platinum, mercury, vanadium, tungsten, and so forth.
- III. Non-metallic Resources.
    - A. Structural Materials: Cement, lime, sand, gravel, stone, slate and clay, and so forth.
    - B. Abrasive Materials: Millstone, emery, and so forth.
    - C. Chemical Materials: Arsenic, borax, gypsum, salt, sulphur, and so forth.
    - D. Pigments: Barytes, etc.
    - E. Miscellaneous Materials: Asbestos, asphalt, graphite, magnesite, and so forth.

Origin of minerals.—According to the geologists all minerals have been derived from igneous sources within the earth. Practically all known geological processes have probably contributed to their deposit, formation, and modification. All that can be said here is that vulcanism, water, and organic agencies have been important factors in these processes. Probably so far as value goes the greatest part of the mineral deposits taken as a whole has been produced through the sorting process of sedimentation; the same processes that have formed sandstone, shale, and limestone. It is also likely that the best results of mineral formation have been attained at and near the surface.[4] However, no one knows what might be found could we get to greater depths; but it may be said that such exploration is beyond the field of the geographer.

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[2] There are 1500 known mineral species, of which only about 200 appear among the mineral resources of commerce.

[3] "Conservation of Natural Resources in the United States," p. 16.

The Production and Utilization of Minerals.

World production and distribution.—Including in general, rocks, ores, and metals, whether solid or liquid, it is estimated that each year the world production of mineral resources aggregates approximately 2,000,000,000 tons, not of course, including water. Coal probably accounts for almost 70% of this total output of crude minerals, stone and clay 10%, iron ore 9%, oil 4%, copper ore 3%. Expressed in values, this total mineral product amounts in round numbers to about $9,000,000,000. In a general way, coal represents about 61% of this value, oil 10%, iron 6%, copper 5%, and gold 3%.

The geographical location of this great mining and smelting output shows a remarkable concentration around the basis of the North Atlantic Ocean, 85% coming from these regions. The United States leads with 39%, England accounts for 18%, and Germany 18%; these three countries producing 75% of the total. The geographical output by continents is: Europe almost 51%, North America about 42%, Asia 4%, and the other continents together only about 4%.[5]

It should be noted, however, that this marked concentration of production and smelting in a few places in the world does not mean that there are no great mineral deposits in other parts of the world. It is merely another evidence of the significance of the social factor in geography. Immense mineral resources lie beneath the surface in Asia, Africa, and South America awaiting development. But environmental factors alone cannot produce great industrial advancement. There must be the combination of natural resources with human initiative and energy.

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[4] Leith, "Economic Aspects of Geology," p. 8.

[5] *Ibid.*, pp. 60–63.

Minerals used as food.—Minerals are useful to human beings in many ways but perhaps first in importance should be classed their use for food. Food should contain water and certain common minerals; such as, iron, sulphur, magnesium, phosphorus, potash, and salt. A man weighing one hundred and fifty pounds is said to contain a hundred pounds of water. Iron goes into the make-up of his blood; lime combines with phosphoric and carbonic acids to make his bones and teeth solid; phosphorus is supposed to aid brain activity; and salt is essential to digestion and excretion. Each of these minerals, except salt, and perhaps iron, is usually contained in sufficient quantities in other foods; as, meats, bread, and vegetables. (Iron is sometimes given as a medicine.) Salt, however, is of such utility to man that it requires further treatment here.

Salt is required by animals as well as by man. They will travel long distances to get salt. When the white man first came into the Middle West he found well-marked buffalo roads leading from the feeding grounds of that animal to salt licks. These salt licks or springs, as in Licking County, Ohio, which thus got its name, often became a source of salt supplies for the early settlers, who previous to that had to depend on salt brought over the Appalachian Mountains at much trouble and expense.

Salt is used not only as condiment in seasoning food, but also in preserving food; as, in curing meat. Chemical industries use salt in the manufacture of many sodium compounds. And some salt is also used in the pottery and hardware industries in making glazes and enamel.

Most countries of the world either have salt supplies of their own or can get it from countries close at hand. This is due to the wide distribution of salt in the deposits of the continents and to its availability from ocean or salt lake brines. Nearly all of the deposits of common salt are believed to have been formed originally by the evaporation of salt water, either from the ocean or from water bodies. The United States produces about 20% of the world's annual consumption of salt; but Great Britain, France, Germany, Russia, China, and India are also big producers.

In 1925 there were 70 salt-producing establishments in the United States, their output being valued at $34,253,000.[6] Fourteen states produce salt; but 85% of our output comes from Michigan, New York, Ohio, and Kansas. The reserve supplies are practically inexhaustible. Some coarse sun-evaporated sea salt, desired by fish and pork packers, is imported into the United States mostly from Spain, Italy, Portugal, and the British and Dutch West Indies. Some specially prepared kiln-dried salt, used by butter makers, is imported from Liverpool, England. There is also some salt imported from Canada, doubtless on account of geographical location. On the other hand we export some salt, chiefly to Canada, Cuba, and New Zealand. But neither our exports nor our imports are as much as 5% of our domestic consumption, which is rapidly increasing.

Most of the salt produced in the United States is obtained by pumping water down to the underground deposits to dissolve the salt and then pumping the brine to the surface where it is evaporated. About 25% of our product, however, is mined like coal through a shaft. One of the largest salt mines in the United States lies beneath an important industrial section of Detroit. From this mine a daily output of some 1400 or 1500 tons of industrial salt is produced by workmen, for whose protection of life and health, tons of fresh air must be pumped down every hour, a fifth of a mile below the city.

Some of the deposits in Michigan and New York are 21 feet thick, with several separate beds occurring in a section a few hundred feet thick. At Stassfurt, Prussia, however, salt beds 300 to 500 feet thick are found.

Minerals used in agriculture.—Since many minerals contain elements necessary as plant food, it results that agriculture has much need of certain minerals. Plants must have oxygen, hydrogen, nitrogen, carbon, calcium, silicon, iron, phosphorus, magnesium, and potassium. Some of these elements are obtained from the soil and the subsurface water and some from the air. But every crop takes away some of these mineral foods, and unless they are replaced in some way the fertility of the soil is exhausted. This accounts for the importance of fertilizers in agriculture. Exhausted soils are common in the eastern, southern, and particularly the southeastern parts of the United States, where many farms, worn out by the long-continued growing of cotton and tobacco, require much fertilizer to produce crops now.

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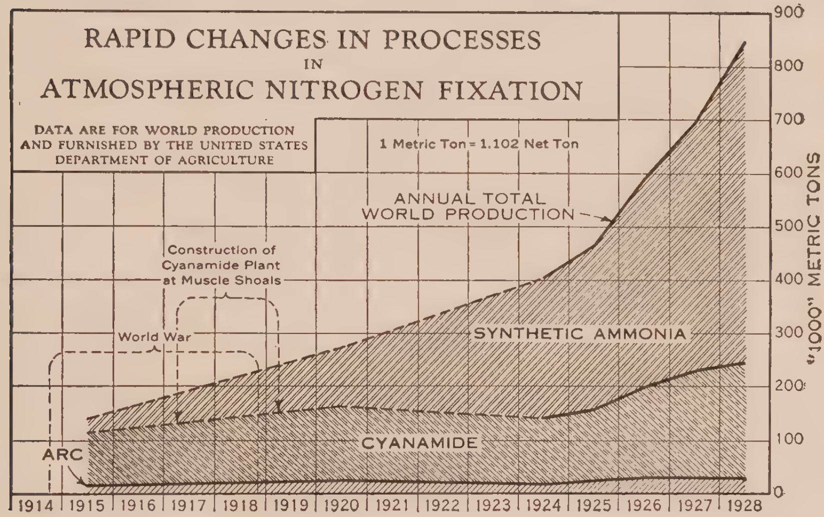
[6] *Commerce Year Book*, 1928, Vol. 1, p. 568.

Because of its physical effects and because of its direct use in the formation of plant substances, calcium is one of the most essential substances in the soil. It is the important ingredient of limestone, hence limestone soils are proverbially fertile soils; as, the Blue Grass region of Kentucky. On the other hand, the use of lime or ground limestone as a fertilizer is necessary on other soils. The higher the clay percentage of a soil, the more lime it should receive to have the advantages of a calcareous soil. Fortunately limestone is a very widespread underlying rock, therefore the supply of lime as a fertilizer is abundant.

Nitrogen, for fertilizer purposes, comes from several sources. There is an unlimited supply of it in the air, but the difficulty has been to take it from the air and transfer it to the soil making it available for plant growth. Certain plants, like clover, have the power of taking nitrogen from the air with the aid of bacteria, so such plants are much used in crop rotation and are plowed under. Nitrogen in the form of ammonia is also saved from coal as a by-product of oil-shales.

Mineral nitrates as a source of fertilizer come almost entirely from northern Chile, one of the most arid tracts in the world, where the sodium has become concentrated in nitrate deposits, called Chile saltpeter. On account of the fixed nitrogen in them, these are mined on a large scale and shipped to many humid agricultural regions of other countries. Thus, through mineral nitrates, a most arid desert has contributed much to the fertility of humid areas.

During the Great War, the Allies were embarrassed by their dependence upon Chile for nitrates, which are also used for making munitions. Germany has been developing processes of taking nitrogen from the air, until now she can in this way not only meet her requirements but even compete with Chilean nitrates in the world's markets. Other countries were stimulated to seek and improve methods of taking nitrogen directly from the air, such as the use of electricity generated by water power, the "cyanamide" process of making synthetic nitrogen by combining atmospheric nitrogen with certain chemical compounds, and the "direct synthetic ammonia" process, which accounted for 70 per cent of the world production in 1928.[7]



Courtesy of Samuel S. Wyer

Fig. 96.

The United States has been active in this movement. As a result, we may expect in the near future important readjustments in agricultural areas. For example, cheaper fertilizers, by increasing the productiveness of land, may lessen the number of farm laborers needed, and thus increase the already rapid movement of population from country to city. (Fig. 96.)

Other mineral fertilizers are those providing potashes and phosphorus. Geological deposits of the phosphates are found in South Carolina, Florida, Tennessee, and Arkansas, with still larger reserves in Wyoming, Utah, Idaho, and Montana. Other deposits occur in North Africa, Russia, Belgium, northern France, and in some of the islands of the Indian and South Pacific Oceans. Commercially important deposits are found also in Spain, Canada, and Norway. As phosphorus is one of the rarest of the essential plant foods, it should be conserved where possible. Considerable percentages of it are contained in city sewage. This suggests the control of sewage so that it may be applied to farm land instead of being wasted in rivers and the ocean. Large deposits of potash are found in Germany and France.

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[7] The recent rapid changes in methods of fixing nitrogen in the air, which consists of about 80% of nitrogen, are very important to agriculture, as is indicated by the estimate that each year in the United States 9 million tons of nitrogen are removed from the soil and only 5½ million tons returned to it.—S. S. Wyer, "Study of Electric Light and Power Service," p. 36.

The utility of minerals in construction work.—From the days of the caveman to the time of the modern city apartment house, men in certain environments have made use of mineral resources to construct their dwellings. Sometimes man has thus merely made use of natural *rock caves* without change. Other times he has improved those, as in the case of the cliff dwellers of the arid southwestern part of the United States, until they became veritable apartment houses. (See Fig. 97.) Sometimes the *adobe* or sun-dried brick has been the building material, as in North Africa and Arizona. (See Fig. 98.) At times rough stones have served, and at other times the blocks of stone have been hewn and fitted with remarkable care.

Stone and buildings.—Perhaps the greatest geographical significance of stone lies in its usefulness as building material. Granites, sandstones, limestones, and others have supplied the material with which man has exercised his practical and artistic powers in erecting dwellings, castles, monuments, and cathedrals. Some relationship may be traced between the stone and the edifice, between the availability of the material and the style of architecture. Vidal de la Blache, a great social geographer of France, says:

> Mayan construction cannot be thought of apart from the limestones of Yucatan, just as the sandstones hemming in the Valley of the Gangus on the south bring up images of the innumerable monuments in the cities between Delhi and Benares, or sandstones of the Vosges, the cathedrals and castles of the Rhine Valley.

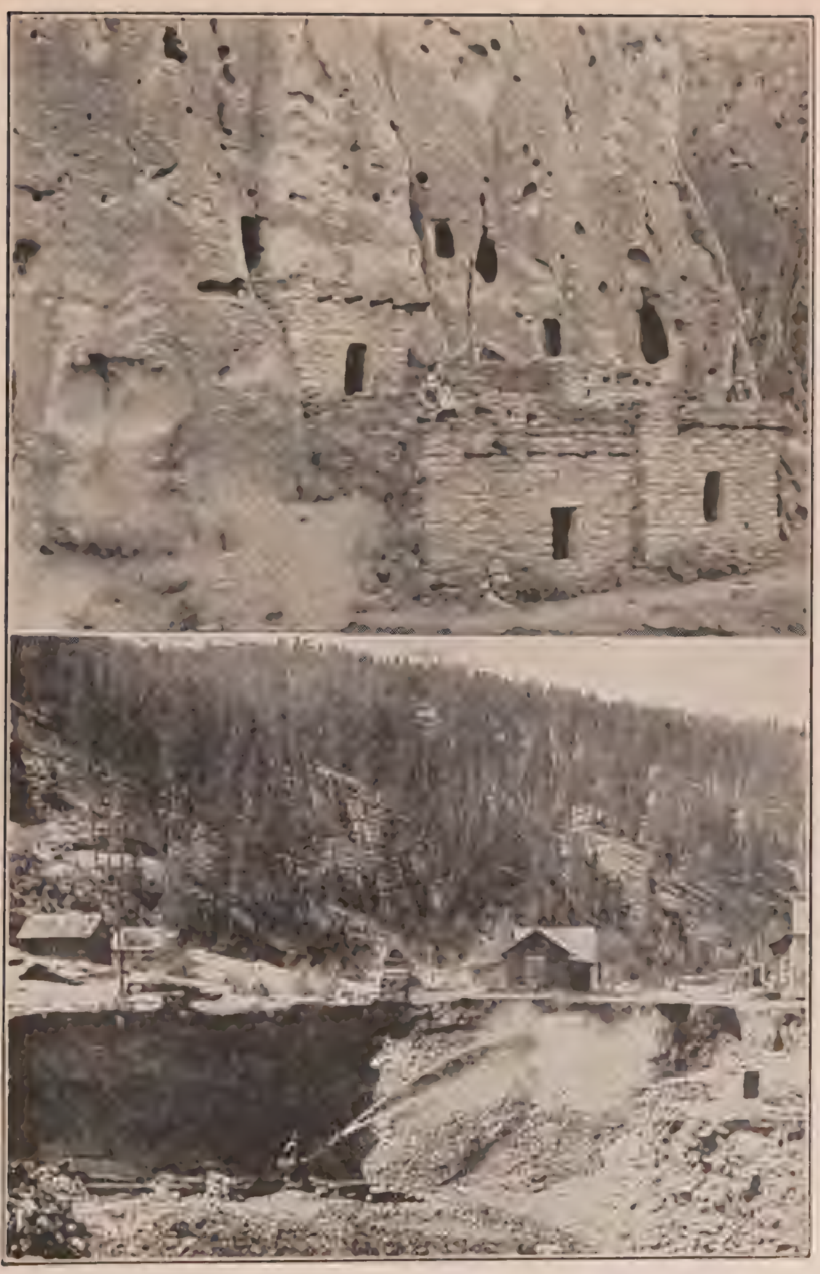

Fig. 97.—The Utilization of Mineral Resources.

Upper.—Restored ruins of cliff dwellers, Bandelier National Monument, New Mexico. (Photo by E. S. Shipp, U. S Forest Service.)

Lower.—Hydraulic Mining. (Photo by B Willis, U. S. Geological Survey.)

> The numerous rock engravings of the Algerian Sahara which show the early artistic aptitudes of the Berber race are carved in sandstone. Sandstone has preserved in astonishing perfection mouldings and ornaments of the buildings of Petra. The fortified Pueblo villages in Colorado and New Mexico are usually made of sandstone quarried in the vicinity. . . . Nowhere has stone architecture had a more beautiful abode nor been made better use of than round about the Mediterranean. . . . Also the Mediterranean region should be considered the mother-country of the art of stone construction, whence, after having inspired various types in its native land, its influence has spread in all directions. . . . The advance of European civilization from the shores of the Mediterranean to the edge of the northern forests is marked by a line of stone structures. Cement combined with stone has made it possible for the network of Roman roads to endure throughout the ages. . . . The gradual replacing of wood by stone has kept pace with the march of progress. The twelfth and thirteenth centuries, which witnessed the re-establishment of order and security in Europe, were also those which witnessed the triumph of stone. Then it was that cathedrals were reared and that at Paris, on the Seine, at London, on the Thames, and elsewhere, stone bridges took the place of primitive wooden bridges.[8]

In the United States east of the Mississippi, the original forest provided cheap and abundant building material, but the *increasing scarcity of wood* and the resulting increase in cost are impelling the people of America, like those of other countries, to make more use of mineral resources. All of us in our country have witnessed the replacing of many wooden houses, fences, and bridges with more modern and more durable structures of stone and brick, tile and steel, and reënforced concrete.

Mining industries.—Something has already been said of the extent of and production of the world's mining industries as a whole, and of particular mineral industries in the United States and elsewhere. In later pages more will be said of certain mineral resources important in particular industries, but, of course, space forbids any attempt at even a fairly complete list of such mineral utilization. It may be said here, though, that in the United States in 1925, the mining industry, including quarrying, employed 1,065,000 workers and the value of the

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[8] "Principles of Human Geography," pp. 249, et seq.

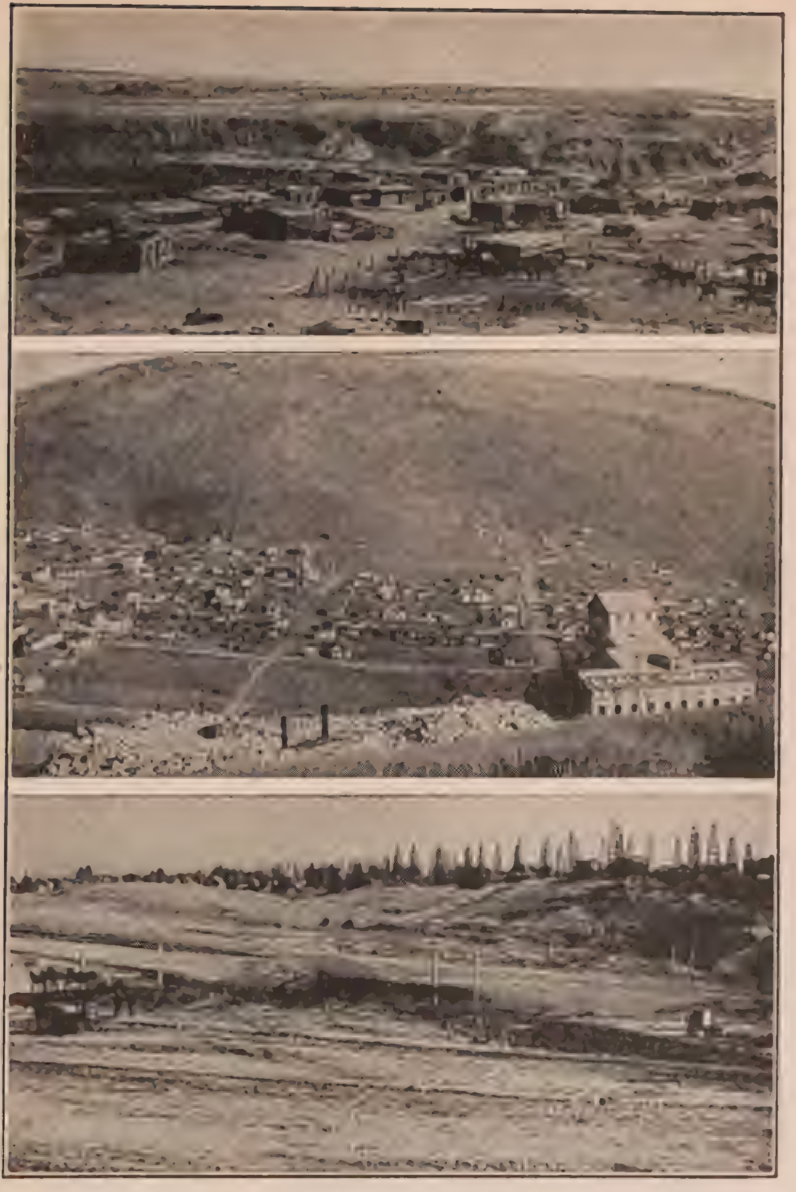

Fig. 98.—Activities in Regions of Slight Rainfall.

Upper.—Moenkopi Village, Arizona. Pueblo architecture of the Village Indians. (Photo by Gregory, U. S. Geological Survey.)

Middle.—A mining town. (Photo by F. L. Ransome, U. S. Geological Survey.)

Lower.—Derricks in oil field, Long Beach, Calif. (Photo by R. Arnold, U. S. Geological Survey.)

output was $4,300,000,000.[9] Outstanding among the minerals included in this vast production are those energy resources used for fuel and power, that is, coal, petroleum, and natural gas.

Coal is the most important of these. The countries producing the most coal are around the North Atlantic. The United States produces about 40% of the total, Great Britain and Germany each about 20%. Other countries in the usual order of production are: France, Poland, Russia, Belgium, India, and Czechoslovakia, Japan, China, Canada, and New South Wales. The leading countries in production also have large reserves. Besides these countries, China also has large reserves which promise much for her future development. Of *the world's coal reserves,* it has been estimated that the United States has over half the total, Canada a sixth, and China nearly a seventh; these three countries thus containing over 82% of the coal resources of the world. Germany comes next with 5.7%, followed by Great Britain with 2.6% and Oceania and Siberia each with 2.3%, no other country having as much as 1%.

One important feature of the coal situation is that the important centers of production are not far from the centers of iron production. In the case of both there is a marked absence of important production in the southern hemisphere.

In the United States the *anthracite* deposits and production are localized in eastern Pennsylvania. The *bituminous* production is localized in Pennsylvania, West Virginia, Ohio, Indiana, Illinois, and Kentucky. There, also, are the principal reserves; but other important known deposits are in Texas, North and South Carolina, and in the Rocky Mountain and Coast states. The west also has large deposits of *sub-bituminous* coal, not yet mined to a great extent. There are also large fields of *lignite* along the Gulf Coast and in the Northern Plains region. About one-sixth of the bituminous coal mined in this country is made into coke. (See Fig. 99.)

Petroleum comes next to coal among minerals as a source

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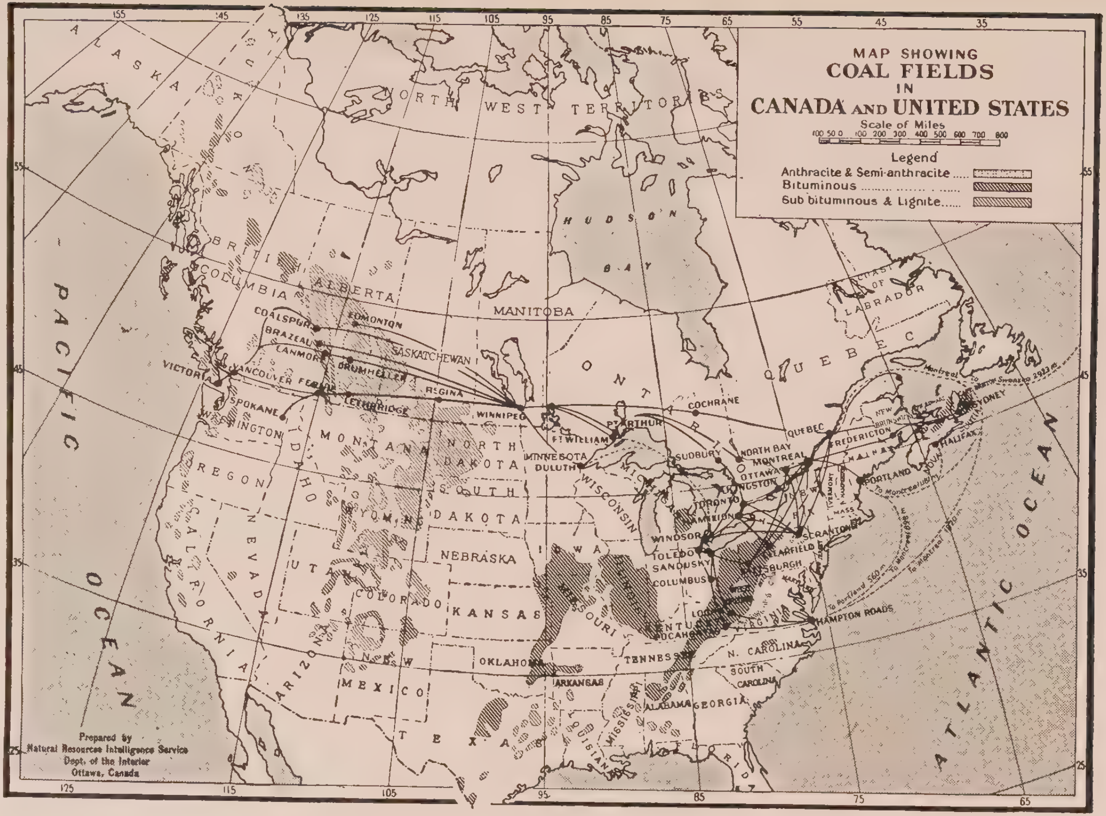
[9] *Commerce Year Book,* 1928, Vol. I, p. 17. The mineral industries of the world employ about 6,000,000 persons.


MAP SHOWING
COAL FIELDS
IN
CANADA AND UNITED STATES
Scale of Miles
100 50 0 100 200 300 400 500 600 700 800
Legend
Anthracite & Semi-anthracite
Bituminous
Sub bituminous & Lignite
Prepared by
Natural Resources Intelligence Service
Dept. of the Interior
Ottawa, Canada
PACIFIC OCEAN
ATLANTIC OCEAN
ALASKA
YUKON
NORTH WEST TERRITORIES
BRITISH COLUMBIA
ALBERTA
SASKATCHEWAN
MANITOBA
ONTARIO
QUEBEC
COAST OF LABRADOR
HUDSON BAY
NEW BRUNSWICK
COALSPUR
BRAZEAU
CANMORE
EDMONTON
DRUMHELLER
FERNIE
LETHBRIDGE
REGINA
WINNIPEG
VICTORIA
VANCOUVER
SPOKANE
FT. WILLIAM
PT. ARTHUR
COCHRANE
SUDBURY
NORTH BAY
DULUTH
QUEBEC
MONTREAL
OTTAWA
KINGSTON
TORONTO
HAMILTON
WINDSOR
TOLEDO
SANDUSKY
COLUMBUS
CLEARFIELD
PITTSBURGH
SCRANTON
FREDERICTON
PORTLAND
HALIFAX
SYDNEY
HAMPTON ROADS
WASHINGTON
OREGON
CALIFORNIA
IDAHO
NEVADA
MONTANA
WYOMING
UTAH
COLORADO
ARIZONA
NEW MEXICO
NORTH DAKOTA
SOUTH DAKOTA
NEBRASKA
KANSAS
OKLAHOMA
TEXAS
MINNESOTA
IOWA
MISSOURI
ARKANSAS
LOUISIANA
WISCONSIN
MICHIGAN
ILLINOIS
KENTUCKY
TENNESSEE
MISSISSIPPI
ALABAMA
GEORGIA
FLORIDA
N. CAROLINA
SOUTH CAROLINA
VIRGINIA
WEST VIRGINIA
POCAHONTAS
LOGAN
NEW YORK
VERMONT
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155
145
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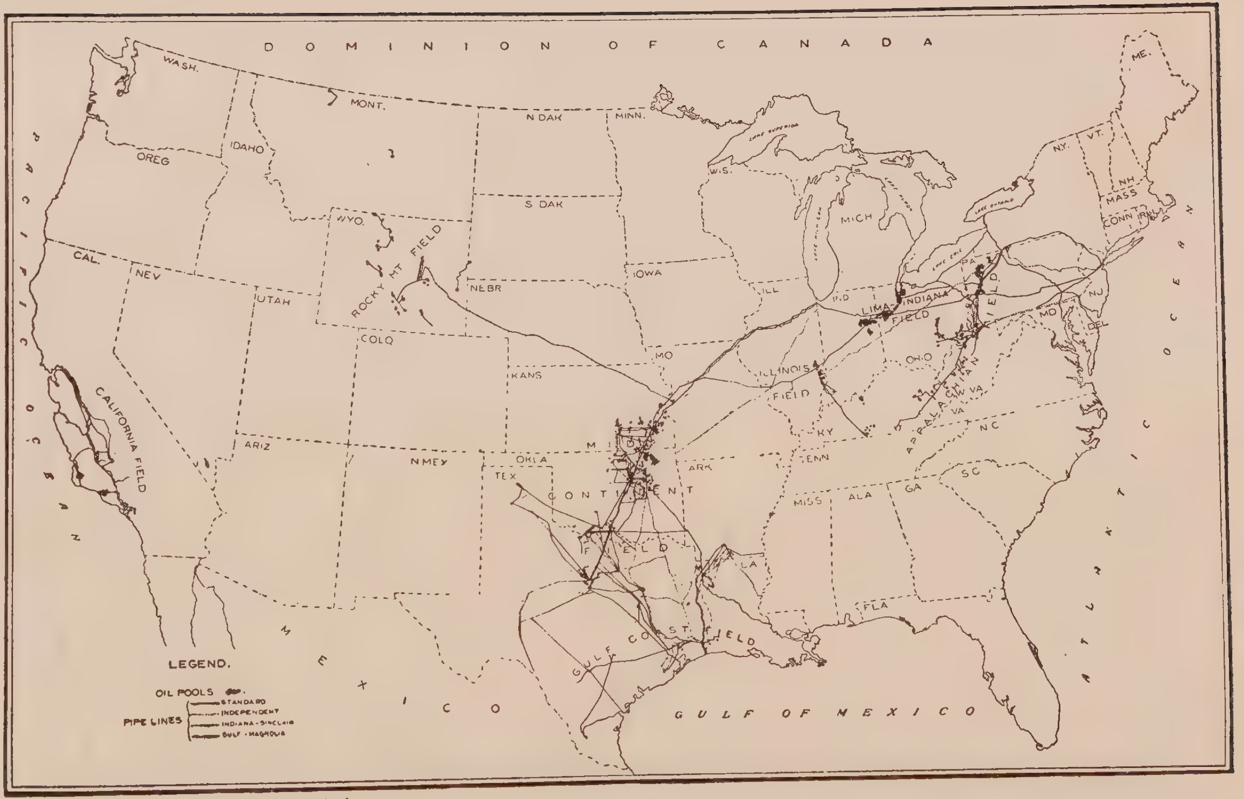
Fig. 99.



Courtesy of the Federal Trade Commission.

Fig. 100.—Location of Developed Oil Fields and Trunk Pipe Lines in the United States, June 30, 1927.

of energy. The demand for oil has increased by leaps and bounds along with the development of the automobile industry. In 1900, the *world output* of crude petroleum was about 149,000,000 barrels. In 1927 it was 1,250,000,000 barrels. The United States produced about 70% of the output in 1926, or 733,000,000 barrels.[10] (See Fig. 100.) The next countries in order of production were: Mexico with 90 million barrels, Russia 61 million, Roumania 23 million, Dutch East Indies 22 million, Peru 11 million; followed by India, Argentina, Colombia, Poland, Trinidad, Sarawak, Japan, and Formosa, each with over a million barrels [11a] All other countries together produced about 800,000 barrels. This also indicates fairly well the *distribution of the reserves.* It shows, too, the concentration of the industry in a few countries and the dominance of the United States. The United States also controls much of the Mexican production as well as production elsewhere. Our domestic consumption has overtaken domestic production, so we look to foreign sources for this great mineral fuel. Here we find an increasing *rivalry among the world powers* that have a keen appreciation of the vital importance of control of oil resources, extremely important in peace as well as in war.

Natural gas is the fuel most nearly perfect. It is used both for fuel and for lighting. So far as known, the *United States leads* all countries in this resource. In 1926, the quantity produced and delivered to consumers in the United States was 1,313,000,000,000 cubic feet. Seventy-eight per cent of this was used by industrial consumers, but there were 3,731,000 domestic consumers. The leading states in production were Oklahoma, California, West Virginia, Texas, Louisiana, and Pennsylvania.

Interstate transportation of gas was greatest from West Virginia, Louisiana, Texas, and Pennsylvania; of these the greatest was from West Virginia to Ohio.[11b] Unfortunately, natural gas is *a limited natural resource* and it is likely that our known supply will be exhausted in a very few years. Other countries producing natural gas are: Canada, Dutch

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[10] *Commerce Year Book,* Vol. I, 1926, pp. 308, 309; Vol. II, 1928, p. 709.

[11a] In 1928, Venezuela ranked second in production of petroleum.

[11b] *Commerce Year Book,* Vol. I, 1926, p. 311; 1928, Vol. I, pp. 313 and 314.

East Indies, Mexico, Hungary, Japan, and Italy. Most producing oil fields yield some natural gas also.

Minerals utilized in manufacturing.—Of course each of the foregoing minerals has its use in manufacturing, either as a raw material, or as a source of power. One important metal, however, must be considered here, namely *iron,* as it is one of the fundamentals of manufacturing, entering prominently into the structure of many of the factory buildings and the machinery used, as well as constituting the raw material of perhaps the greatest group of manufacturing industries, the iron and steel industries. The long story of man's use of minerals in the making of his weapons, tools, and implements begins way back in the Stone Age, runs through the Bronze Age, still in the prehistoric period, and continues through the Iron Age of which he is still in one stage.

Except in recently fallen meteorites, iron is never found in the pure metal, but there are many iron ores. They are, however, not of equal value. Like coal, iron ore has a wide distribution, but it is produced and smelted on a large scale only in a few places where there are *favorable conditions.* Such conditions include: high-grade iron ore in large quantities; reasonably near an abundance of coal; cheap transportation to markets; and human enterprise.

More than $\frac{9}{10}$ of the world's iron ore production is in the countries in the proximity of the North Atlantic. The United States leads again with some forty per cent. France follows with about 12%, United Kingdom, about 10%, and Germany (before the war) 5 to 20%. Smaller producers are Sweden, Luxemburg, Spain, Russia, Algeria, India, Chile, China, Czechoslovakia, and Austria. The production of the United States in 1926 was 67,623,000 long tons. Of this total over 57 million tons came from the Lake Superior district, and nearly 7 million from the Birmingham district.[12] The Lake Superior district, especially in northern Michigan and Minnesota, contains by far the most important deposits of the United States. The reserves of this district are estimated at about 73% of the available ore of the United States, and about 95% of the low grade deposits.

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[12] *Commerce Year Book,* 1926 Vol. I, p. 363.

Mineral resources in trade and transportation.—Whether one considers the steel structure of steamships, pullman and freight cars, steel rails of the railway tracks, or stone and steel and concrete of culverts and bridges; or whether one has in mind the mineral fuels that furnish the energy and power that move the ships, trucks, or trains; or whether one has in mind the millions of tons of coal, iron, copper, and other ores that make up so large a proportion of the traffic that is carried; one must come to the conclusion that mineral resources play a most important part in the transportation business of the world.

Likewise, one has only to read the list of exports and imports of various countries and the receipts and shipments at primary domestic markets to realize the high place, either in quantity or value, that is occupied by mineral resources and products both in the domestic and the foreign commerce of the leading countries of the world.

There is one other way, however, that minerals play a significant part in commerce and that is as money. Money is both a medium of exchange and a standard of value, and hence is of incalculable importance in facilitating commerce. As gold and silver are the great money metals, their part in commerce is at least threefold. As money, they facilitate the buying and selling. As bullion, they are commercial commodities themselves, being bought, sold, and shipped. And as the quantity of gold increases or decreases in any country, it tends, other things being equal, to cause a corresponding rise or fall in the prices of other commodities. So the abundance or scarcity of the supply of the great money metal has a close relation to the cost of living.

The outlook for the future.—The immediate prospects for mineral supplies in the United States are encouraging. The outlook for the more distant future, however, is not so promising. For the next few years, our own mineral resources plus our imports from well-established sources are sufficient to provide for an increasing population with a rising standard of living. But, unless science will find some new source of energy not now available, it does not appear that even our great reserves of minerals will be sufficient to support permanently, at present standards, a population as large as we now have.

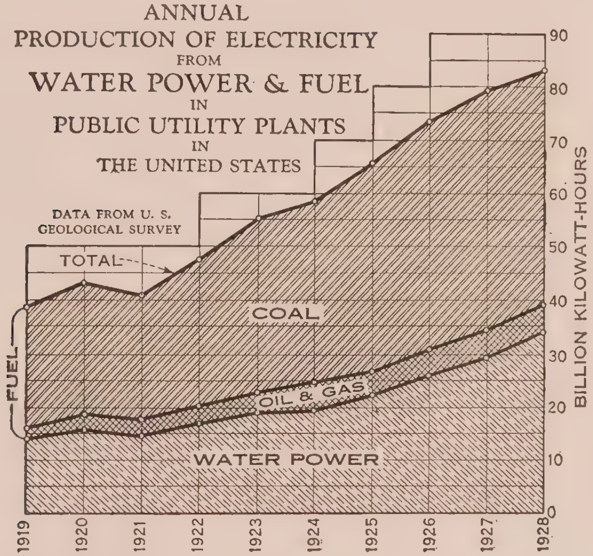
The United States stands first in the production of coal, iron, copper, silver, aluminum, zinc, sulphur, and phosphates; and well up in minerals like quicksilver, magnesite, and vanadium. We have a *strong competitive position* and, besides being so nearly self-supporting in minerals, we can mine them, as a whole, and deliver them to the factories at as low a cost as any other country. But our consumption of minerals has increased even faster than the production.

Moreover, the *world's consumption* of minerals has been increasing with remarkable rapidity. While this has contributed greatly to the rising standards of living during the past century, at the same time, it means that to repeat these achievements during the coming century will require ever-increasing supplies of these important minerals. In some cases, the drain on the reserves is already beginning to be felt.

The danger lies not so much in the possibility of complete exhaustion, but in *constantly increasing costs.* The best ores are generally exploited first. To utilize the lower-grade ores, to which we eventually must resort, means a tremendous additional drain upon our energy resources, particularly coal and petroleum. Whether we extract nitrogen from the air, or transport iron ore from Brazil; whether we use copper ore with a 20% metal content instead of that having 50% of metal in it; it takes more and more energy to get the same results, to say nothing of the increasing production needed for a growing population.

This means an *increasing dependence upon power.* The rate at which our dependence upon the energy resources of coal, oil, and water power has increased during the 20th century is astounding. The last century saw a seventy-five-fold increase in the consumption of fuels. But, of our total production of oil and coal down to 1929, it is estimated that 78% of our coal output and 92% of our oil have been produced since 1900. Likewise 98% of our electric power has been produced during the 20th century.

These facts indicate, somewhat, our rapid pace, and, in spite of increasing resort to substitute sources of energy, they point to a not distant *future of diminishing abundance and rising costs* of mineral products, which will make it increasingly difficult to support our present population at our present standard of living.



Courtesy of Samuel S. Wyer.

Fig. 101.

It is difficult to get most people to think seriously of such future problems. But one may well quote an authoritative article on our mineral resources by two members of the Division of Mineral Resources of the United States Geological Survey:[13]

> "A permanent civilization must learn to balance its energy budget, to collect each year from the inexhaustible sources of water, wind, and sun as much power as it expends. A rational view of our stores of the mineral fuels would regard them as a bonus to be used in acquiring the skill and in building the engineering works needed to harness the inexhaustible sources of power."

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[13] F. G. Tryon and Lida Mann.

CHAPTER XIV

WATER AND ITS UTILIZATION

Water as an Element in Environment.

Water essential to life.—Perhaps the most striking geographical fact, observed when one looks at a globe, is the division of its surface into continents and oceans, into land and water. At first thought, it is apt to strike one that the land is by far the more important, because it is there that most people live and carry on their activities. The importance of water as a factor, in our environment, however, is at once evident when we reflect that along with sunlight and air, water is one of the predominant elements that make life possible on this planet.

In one sense, water is even more important to man than food, in that his existence probably would end somewhat more abruptly if his water supply were cut off than if he were deprived of food. But, of course, both food and water are absolute necessities. Man's food, however, consists chiefly of plants and animals and neither of these forms of life can continue without water.

As life has always adapted itself to temperature conditions, so through long ages of development both plants and animals have likewise become adjusted to definite ranges and limits of moisture conditions. Such adjustment is so marked in the case of plant life that it has been selected by botanists, agriculturists, and plant geographers as the basis for a major grouping of all plants.[1]

Xerophytes.—Those plants able to adjust themselves, through structures or function or both, to dry conditions of both soil and atmosphere during the growing season.

Hydrophytes.—Those able to make adjustments to moist conditions of both the air and the soil.

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[1] F. A. Buechel, "The Commerce of Agriculture."

Mesophytes.—Those better suited to medium moisture conditions in soil and atmosphere during the growing season. Most of the agricultural plants of the world are mesophytes, rice being an outstanding exception.

Consequently the range of moisture conditions of soil and air is very important for agricultural crops. Wheat, for example, needs medium moisture conditions of both air and soil during its vegetative season, but during the maturing season it needs a moderately moist soil but a warm and dry condition of the atmosphere.

Various sciences study water.—The waters of the earth in general are the subject of study of a special science, *Hydrology,* but this water may be divided into three parts: (1) that which occurs in the atmosphere, (2) that which rests on the surface of the solid part of the earth (the lithosphere), and (3) that which occurs below the surface of the land. Some of the geographical aspects of atmospheric water have been considered in previous chapters on climate, so that here we are concerned chiefly with (2) and (3) above.

It may be noted here, however, that geography is not the only science having to do with even these divisions of water. Various sciences deal with special aspects of water. Thus atmospheric water comes within the province of *meteorology;* surface water is the principal field of *hydraulic engineering* and is also of interest to *geology* and other sciences; while water below the surface is considered by the geologist; and that part of it near enough to the surface to be reached by the roots of plants is of special interest to the students of soils and *agriculture.* Nevertheless, water as an element in the environment influencing man and his activities, and as utilized by him in adapting himself to his environment, is a most important geographical factor.

Classification of water.—Chemically pure water (H_2O) is never found in nature, as it is always combined with solids, liquids, and gaseous materials, which it holds in solution or suspension. So the term, natural water, is used to designate water as it exists in or on the earth in its natural condition. As the *atmosphere,* the outer part of the earth surrounding the solid *lithosphere* and its surface waters, consists predominatingly of air but contains other materials, including water; so the liquid and solid water, or *hydrosphere,* that rests on the lithosphere, contains solid, liquid, and gaseous materials that are suspended or dissolved in the water. As in the case of atmospheric water, so surface water may be in liquid or solid state, and subsurface water may be either liquid, solid, or gaseous. Water frequently passes from the atmosphere into the lithosphere and from the lithosphere into the atmosphere. Any water discharged from one of these and not received by the other remains on the surface until it can be taken into one or the other. The frequent changes in the water-holding capacity of the air are the chief causes of continual movements in both surface and underground water; and the principal reason for the continual round of evaporation, condensation, and precipitation that prevents the attainment of static equilibrium in the water of the earth.

Surface water includes oceans, seas, lakes, rivers, canals, and so forth, terms which are of everyday occurrence and familiar to everyone. A hydrologist, however, according to the systematic method of the natural scientist, would likely give a more detailed outline as, for example, the following:

CLASSIFICATION OF SURFACE WATER.[2]

I. Land water:
  A. Surface snow and ice; including glaciers, ice sheets, and other bodies of snow and ice that rest directly on the land.
  B. Flowing surface water:
    1. Flowing sheet water.
    2. Streams:
      With respect to origin:
        a. Natural streams—rivers, creeks, and so forth. This class can be subdivided according to the geologic history—for example, consequent, subsequent, superimposed, and antecedent streams.
        b. Artificial streams—canals, and so forth.
      With respect to permanence:
        a. Perennial streams.
        b. Intermittent streams.
          (1) Spring-fed intermittent streams.
          (2) Surface-fed intermittent streams.

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[2] O. E. Meinzer in *U. S. Geol. Survey,* Water Supply, Paper 494, p. 16. According to some authorities, large permanent ice sheets, such as the ice-cap of Greenland, are regarded as belonging to the lithosphere.

- *c.* Ephemeral streams.
- With respect to continuity in space:
  - *a.* Continuous streams.
  - *b.* Interrupted streams.
    - (1) Intermittent interrupted streams.
    - (2) Perennial interrupted streams.
- In relation to subsurface water:
  - *a.* Influent streams.
  - *b.* Effluent streams.
  - *c.* Insulated streams.
- C. Impounded surface water:
  - With respect to origin:
    - *a.* Naturally impounded bodies—lakes, ponds, and so forth. This class can be subdivided with respect to the geologic agencies that produce lakes and ponds.
    - *b.* Artificial impounded bodies, reservoirs, and so forth.
  - With respect to permanence:
    - *a.* Perennial impounded bodies.
    - *b.* Intermittent impounded bodies.
    - *c.* Ephemeral impounded bodies.
  - With respect to degree of impounding:
    - *a.* Incompletely impounded bodies:
      - (1) Bodies which perennially discharge water as surface water.
      - (2) Bodies which intermittently discharge water as surface water.
    - *b.* Completely impounded bodies. These bodies never discharge water as surface water.
  - In relation to subsurface water:
    - *a.* Influent impounded bodies.
    - *b.* Effluent impounded bodies.
    - *c.* Insulated impounded bodies.
- II. Ocean or sea water.

The Oceans as a Geographic Factor.

Size of Oceans.—The oceans comprise about three-quarters of the earth's surface or approximately 145,000,000 square miles. Salisbury, Barrows, and Tower state the areas of the five great oceans to be about as follows: [3]

Arctic Ocean	5,200,000 sq. miles
Indian Ocean	28,000,000 " "
Atlantic Ocean	35,000,000 " "
Pacific Ocean	67,000,000 " "
Southern Ocean	5,700,000 " "

Thus the ocean water is not a uniform sheet but consists of irregularly distributed oceans of different size and depth, all connected, however. Between these oceans are the continents in which there are many islands. In fact these continents and islands constitute the *land surfaces,* or *land,* which is really that part of the lithosphere not usually covered with liquid water.[4] The shore lines, or lines of contact between land and water, are very irregular, particularly in the northern hemisphere, where the land area is indented by many bays, harbors, and even great inclosed seas.

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[3] Salisbury, Barrows, and Tower, "Elements of Geography," p. 228.

The oceans cover a very much larger area in the southern hemisphere than in the northern. In fact they completely encircle the earth at 60° south latitude, hence the name *Southern Ocean* is often given to the ocean waters south of that parallel (60°S.), that is, to the Antarctic Ocean. A picture or map of a globe with New Zealand approximately at the center shows so preponderating an area of ocean water that the hemisphere, so depicted, is called the water hemisphere. (See Fig. 65.)

The high proportion of water to land in the southern hemisphere and the so-called water hemisphere has very *important consequences,* for example, in the way of climatic influences and in the matter of the isolation of peoples and regions in this part of the world. The great distances of these regions from the great centers of population, production, and markets of Europe and North America have seriously affected transportation costs and other things, such as the frequency and extent of commercial and social intercourse and contacts, which mean so much for civilization.

Ocean conditions.—The ocean basins vary in depth from a few feet in many places near the land to more than 31,000 feet in others. The average depth of the ocean water is nearly 13,000 feet, or about two and a half miles. The areas which are far more than the average depth are called *deeps.* In the northern Pacific, near the Ladrone Islands, soundings have recorded a depth of 31,614 feet, or more than the height of the highest mountain, Mt. Everest in the Himalaya Mountains, which is 29,002 feet high. In the Atlantic Ocean, north of Porto Rico, Blake Deep is 27,366 feet in depth. These great deeps, however, occupy areas as limited perhaps as the high mountains; and around the continents in most places there exists a broad platform 600 feet or less in depth called the *continental shelf*. (See Fig. 135.) This continental shelf with its relatively shallow water is of great importance to man. For example, there are found there, some of the great fishing grounds of the world, notably those of the Newfoundland Banks and of the North Sea.

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[4] The science which makes a systematic study of oceans and ocean basins is called *oceanography.*

Some of the areas over the continental shelf are known as *seas;* namely, the North Sea, mentioned above, the Baltic Sea, and the English Channel. Seas may be distinguished as (1) marginal, (2) continental, and (3) inland seas. The first are located at the edge of great ocean basins with which they communicate over ridges in the ocean bottom, and through straits deep and wide enough to permit the seas to share, considerably, the life of the ocean basins. The following are marginal seas: the North Sea, the Caribbean Sea, and the Sea of Japan. Continental seas extend more deeply into the continents and connect with the ocean only through narrow openings of but little depth. Examples of these are: the Baltic, the Black, and the Mediterranean Seas. Inland seas such as the Caspian and the Aral are very similar to lakes. Conditions of seas are so different from oceans that the laws regulating the distribution of temperature, density, currents, and so forth, of oceans cannot be said always to apply in the same way to seas.

The total *volume* of the ocean water is some fifteen times that of the land, that is, the volume of the land above sea level, as the mean elevation of the spherical surface of the ocean is called. It is said that if all this land above sea level were dumped into the sea, the level of the water would rise approximately 650 feet.

Salinity of ocean waters.—Differing from most of the land water, the ocean water is decidedly salt. While this salt constitutes only from 3.3% to 3.7% of the whole of ocean water, so much larger is the volume of the oceans than that of the lands, that if all the salt dissolved in the oceans were spread over the land it would make a layer over 400 ft. thick. Besides the common salt in the ocean, there are small percentages of other solids. In fact, nearly all other substances found in the earth's crust are found in very small proportions, in the dissolved mineral matter of the ocean. The proportion of this matter, which is salt, is about 78% in the average ocean water. Of course this salinity differs in different parts of the ocean and also in the various seas. The water of the Mediterranean Sea, for example, is much more salty than that of the ocean.

Oceans and climate.—Oceans are important modifiers of climate. The distribution of their surface heat is important in the explanation of climate. Near the equator the surface water of the ocean is slightly warmer than the mean temperature of the air. This advantage, however, disappears near the tropics of Cancer and Capricorn; but from 40° of latitude on, the water regains its advantage in heat and so the ocean is an important source of warmth right up to the polar regions.[5] In general, the temperature of the ocean decreases from the surface to the bottom. Below a thousand fathoms (6000 ft.) it is nearly everywhere less than 37° F. and this decreases slowly almost to 32° F. This uniformity is probably due to a free circulation of water at great depths.

Ocean movements.—Differences in temperature in ocean water cause movements to start. The warmer water of the tropics is relatively light and so floats, as it were, while that of the colder regions, being heavier, settles down and warmer water takes its place. This is one of the causes of ocean currents and one reason why the surface water changes temperature so slightly. The importance of the circulation of ocean waters at great depths can only be suspected, but it is apparent at the surface where currents exist strong enough to carry ships out of their courses.

Ocean currents form separate systems in the various ocean basins with a swirl in opposite directions in the northern and

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[5] MARTONNE gives the following figures:

Latitude	0°	10°	20°	30°	40°	50°	60°.
Air	78.6 F.	78.4	75.6	66.9	55.6	42.7	32.5°F.
Ocean	79.3 F.	77.9	73.4	66.56	56.0	45.86	34.2

the southern hemispheres; the deflection, due chiefly to the earth's rotation, being to the right in the former and to the left in the latter (Fig. 34). The friction of the trade winds on the surface waters is the *chief cause* of ocean currents. This is evidenced by the fact that the equatorial currents swing to the north in the northern summer, and to the south in winter as the position of the equatorial belt of calms shifts. Moreover, the currents of the Indian Ocean reverse their direction with the seasonal change of the monsoon winds.

The *chief importance* of the ocean currents lies in their influence upon climate. They make either warmer or cooler, portions of the ocean surface, the air over them, and (through the influence of winds) the adjoining lands. Thus polar currents deflected to the west make adjoining east coasts colder, as that of Labrador; while warm currents passing poleward from the tropics are deflected toward the east, thus warming the west coasts of lands like southern Alaska.

Formerly, in the days of sailing vessels, ocean currents were of great assistance to the ships, which, when possible, sailed with the currents. Thus, in colonial days, the great ocean swirl in the north Atlantic was utilized by New England traders in voyages to England, from there to France, Spain, or Portugal, and the Canary Islands, or sometimes, to the African coast for slaves, and then across the Atlantic again to the sugar plantations of the West Indies. The return voyage to New England would be made with stops perhaps at the Carolinas or Virginia which were in line with the course of the Gulf Stream. Modern great steamships are more independent of ocean currents, but the latter still retain considerable commercial importance.

Tides, too, have an important bearing on commerce, in that the entrances to many harbors are sufficiently shallow so that the high tides are of great assistance to vessels coming in or going out. The wavelike rising and falling of the surface of the ocean water, which constitutes the tides, is caused chiefly by the attraction of the moon, but partly also by that of the sun. Since two tidal waves are formed, one on the side of the globe next the moon and the other on the opposite side, along most coasts the tide rises and falls twice a day, or rather every 24 hours and 52 minutes.

It is particularly noticeable along low coasts, rising for some six hours, advancing up the shores like a river overflowing. This is the *flood tide.* Then the falling or *ebb tide* begins and the waters recede. Sometimes the high water mark may be five or six miles further inland than the low water line. These ebb and flow tides are, of course, due to the rising and falling of the ocean surface as the moon revolves about the earth. The ranges vary, however, from day to day. The maximum, called the *spring tide,* occurs about every 15 days, at the time of the new and full moons; while the minimum or *neap tide* comes at the first and third quarters of the moon's phases.

The *tidal currents in rivers* like the Hudson, the Thames, the Mersey, the Elbe, and the Gironde, sweep out sediment brought down to the ocean by these rivers, and thus aid navigation and help make their great estuaries suitable for ports; as, New York, London, Liverpool, Hamburg, and Bordeaux. Continental and inland seas are very little affected by tides and therefore they have no estuary ports. The great Rhone River of France empties into the Mediterranean, the greatest of continental seas, but its great port, Marseilles, is not within the mouth of the Rhone, but near-by on the seacoast.

In some localities, as, for example, in the estuary of the Seine, large power plants have proved successful in utilizing the energy of rising and falling tides; and the immense volume of water so moving, together with its great regularity of movement, indicates that the future will see a remarkable development in the harnessing of tidal power in favorable locations. A French project of this kind is contemplated near Brest, where a great estuary has tides with a range of thirty-five feet. Another, in England, considers damming the Severn River where may be obtained a power production estimated equal to the hydroelectric output of Niagara.

Waves constitute another movement of ocean waters that is of geographic importance. They are caused by the friction of wind on the water surface. In the open ocean, waves do little more than cause the surface to rise and fall, lifting and lowering vessels, for example, but not injuring them except when a violent gale may toss ships about, sometimes sinking small ones or damaging large ones. When waves reach the coasts, however, they lash the shores, often with much fury. At times, destructive waves may cause much damage to ports and shipping in the harbors, as was the case at Galveston, Texas, in September 1900. Usually, however, the work of waves along shore spends itself in washing the sand of the beach back and forth; in wearing away the cliffs of rocky shores; in grinding to sand or sediment the rock fragments thus torn from the cliffs; and in washing ashore this sand, thus, for example, constructing bathing beaches; or distributing it along the shore in spits or bars that may form or block harbors. In either case the result is of geographic importance to commerce. The harbors of the middle and south Atlantic coast of the United States are good examples of those hard to keep open and navigable, on account of the sandy materials of the coast being continually shifted by the action of waves and currents.

Oceans and transportation.—The oceans are of great importance as a *source of food* for mankind, and this use is the basis of the big fishing industries in various parts of the world. No doubt, as world population increases and agricultural land becomes relatively scarcer and more costly, people will depend more and more upon the vast ocean for food. But at present that use of the ocean is far surpassed by its importance as the world's great highway for foreign commerce.

There was a time when the oceans were *barriers* between nations and races. Probably no greater change in geographic relationships between man and his environment, within historic times, can be mentioned, in the case of any other environmental factor, than that which has transformed the ocean from a great barrier between peoples to a world highway for the transportation of people and commodities; a means of communication of ideas, influence, and knowledge. This change has been due to human initiative and activity, a remarkable instance of the importance of the human factor in geography.

The importance of the oceans in commerce and transportation is indicated by the figures showing the value and destination of the exports, together with the value and sources of the imports of the United States for the calendar year 1927, as may be seen in the following table.

TRADE OF CONTINENTAL UNITED STATES WITH FOREIGN COUNTRIES AND WITH OUTLYING POSSESSIONS[6]

	Total	To Foreign Countries	To U. S. Possessions
Exports	$5,056,085,000	$4,782,922,000	$273,163,000
		From Foreign Countries	From U. S. Possess.
Imports	4,420,638,000	4,046,224,000	374,414,000
		With Foreign Countries	With U. S. Possess.
Total Trade	$9,476,723,000	$8,829,146,000	647,577,000

By far the larger part of this total trade of nearly ten thousand million dollars went over the oceans, in ocean-going vessels. The trade which was carried on with the outlying possessions of the United States, of course, was ocean-going trade, for these outlying possessions are the Philippines, Alaska, Hawaii, Porto Rico, the Virgin Islands, Guam, and American Samoa; all of them distant, some of them on the opposite side of the globe.

About 15.5% of our exports to foreign countries in 1926, however, went to northern North America and 8.9% to southern North America, and of course, much, but not all of this went overland, for here we have our two neighbors Canada and Mexico. Likewise 10.9% of our imports from foreign countries came from northern North America, and 11.9% from southern North America. The distribution of our 1926 foreign trade by continents, however, will give a somewhat better idea of the relative distances over the ocean traversed by the bulk of the commodities composing our foreign trade.

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[6] *Commerce Year Book*, 1926, p. 127; published by the United States Department of Commerce. *Ibid.*, 1928, Vol. I, p. 128.

FOREIGN TRADE OF THE UNITED STATES BY CONTINENTS AND GREAT TRADE REGIONS IN 1926[7]

GRAND DIVISIONS	EXPORTS		IMPORTS	
	Value[8]	%	*Value*[8]	%
Europe	$2,310	48.0	$1,286	29.0
North America				
Northern	748	15.5	486	10.9
Southern	429	8.9	526	11.9
Asia	565	11.7	1,401	31.6
South America	444	9.2	568	1.8
Oceania	213	4.4	68	1.5

Thus it is seen that 48% of our exports crossed the Atlantic to Europe, while 29% of our imports came from Europe, and 31.6% of our imports came all the way from Asia. It should not be forgotten, moreover, that these figures indicate the ocean-going trade of the United States alone, and that only for one year. It is only when we think that such use is made of the ocean by the United States year after year, and likewise by other great countries, to say nothing of the small ones, that we begin to realize somewhat the great and constantly increasing importance of the ocean in trade and transportation.[9] (See Figs. 102 and 103 for the geographical distribution of our foreign trade in 1928.)

The water-borne exports of the United States in 1926 amounted in weight to 68,140,000 tons and the imports to 44,686,000 tons. Of this tonnage 64% of all imports and 52% of all our exports were handled in our Atlantic ports.[10]

The international trade of the United Kingdom in 1926 consisted of exports valued at $3,777,000,000, in round numbers, and imports of $6,038,000,000. Even Australia, nearly opposite us on the globe and in the midst of the water hemisphere, had that year $640,000,000 of exports and $770,000,000 of imports.[11]

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[7] *Commerce Year Book*, 1926, p. 112.

[8] Six figures omitted: thus our exports to Europe in round numbers were 2,310 million dollars.

[9] Besides the use of the ocean in foreign trade, the United States, as well as other countries, utilizes the oceans and seas in carrying on an immense coast-wise trade between home ports.

[10] *Commerce Year Book*, 1926, Vol. II, p. 588.

[11] *Commerce Year Book*, 1926, Vol. I, pp. 615, 616, 622.

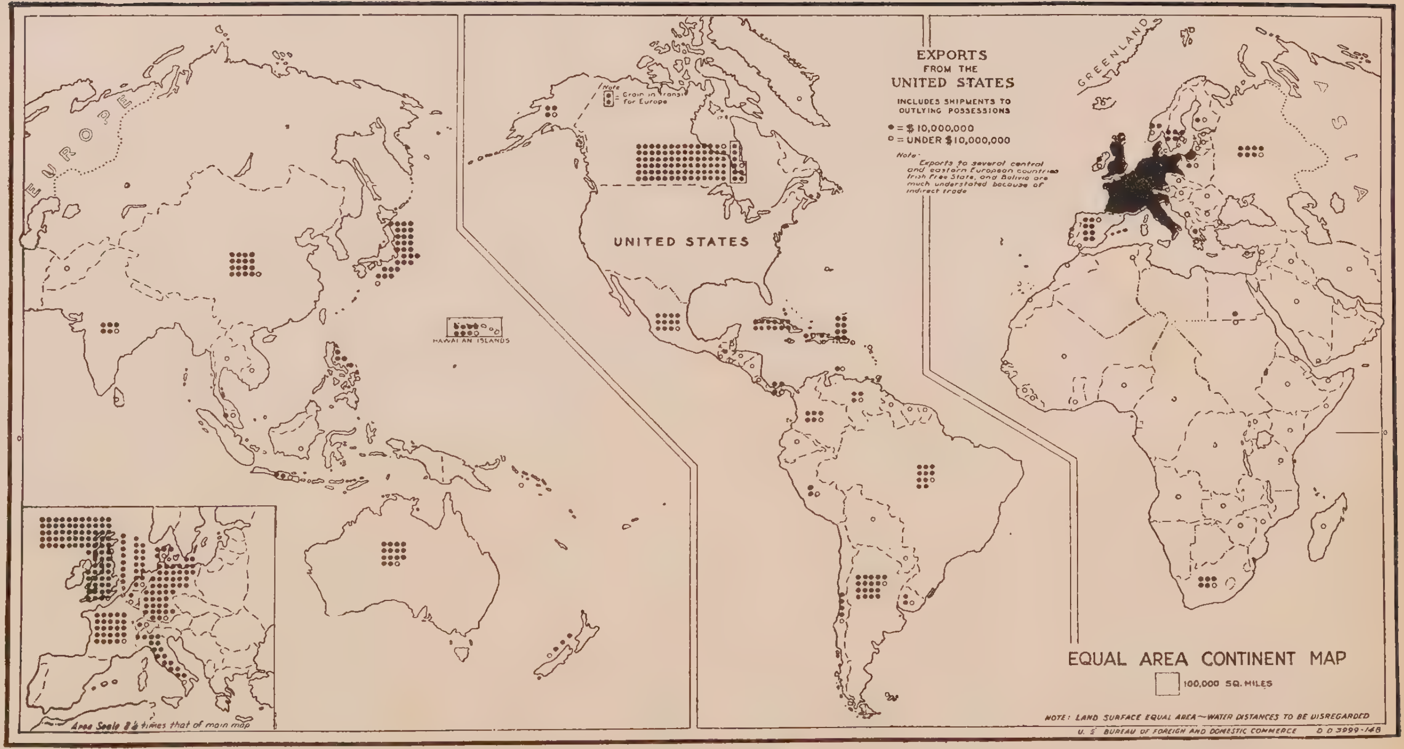
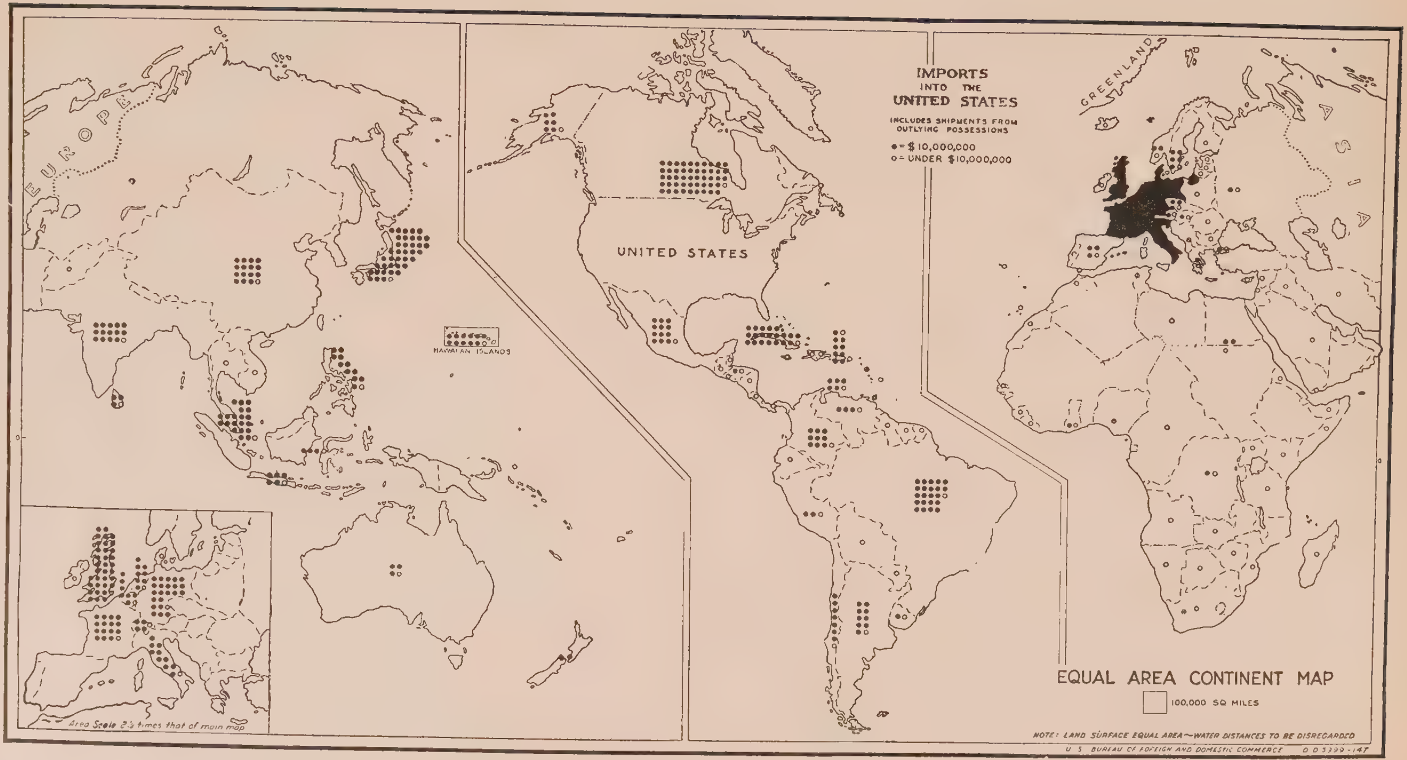

EXPORTS FROM THE UNITED STATES
INCLUDES SHIPMENTS TO OUTLYING POSSESSIONS
● = $ 10,000,000
○ = UNDER $ 10,000,000
Note: Exports to several central and eastern European countries Irish Free State, and Bolivia are much understated because of indirect trade
Note ● = Grain in transit for Europe
UNITED STATES
HAWAIIAN ISLANDS
EUROPE
ASIA
GREENLAND
Area Scale 8½ times that of main map
EQUAL AREA CONTINENT MAP
100,000 SQ. MILES
NOTE: LAND SURFACE EQUAL AREA—WATER DISTANCES TO BE DISREGARDED
U. S. BUREAU OF FOREIGN AND DOMESTIC COMMERCE
D D 3999-148

Fig. 102.—Exports from the United States by Countries, 1928. (For names of countries see Fig. 9.)



IMPORTS
INTO THE
UNITED STATES
INCLUDES SHIPMENTS FROM OUTLYING POSSESSIONS
● = $10,000,000
○ = UNDER $10,000,000
EUROPE
ASIA
GREENLAND
UNITED STATES
HAWAIIAN ISLANDS
Area Scale 2½ times that of main map
EQUAL AREA CONTINENT MAP
100,000 SQ MILES
NOTE: LAND SURFACE EQUAL AREA—WATER DISTANCES TO BE DISREGARDED
U S BUREAU OF FOREIGN AND DOMESTIC COMMERCE D D 5399-147

Fig. 103.—Imports into the United States by Countries, 1928. (For names of countries see Fig. 9.)

On June 30, 1926, the world's merchant marine, measured in terms of steel, steam, and motor vessels (not counting U. S. and Canadian Great Lakes tonnage and Philippine Island tonnage) was 57,844,000 gross tons. Tonnage means space measurement, 100 cu. ft. being called one ton. The world's transoceanic and interoceanic shipping services in 1925–26 were almost wholly carried on by 5575 ocean steamers, each of 4000 gross tons or over, and aggregating 22,210,000 net tons.[12]

In the year 1927–28, the world tonnage, including all vessels of 100 gross tons and over, sailing, steam, and motor, consisted of 32,175 vessels of 65,192,910 gross tonnage.[13]

The Utility and Control of Inland Water.

The ocean as the source.—A final consideration of the importance of the ocean to man is the fact that it supplies almost all the water which is found on, in, or under the land. By means of the sun's heat, water is evaporated from the ocean, which covers three-fourths of the earth's surface; the wind carries much of this water vapor over the land, where condensation, due to cooling, results in precipitation of atmospheric water; as, rain, snow, sleet, hail, dew, or frost. Some of this water, thus precipitated, is again evaporated and later precipitated again. So the water originally evaporated from the ocean may be evaporated, condensed, and precipitated several times before it is again returned to the ocean through the streams.

The classification of the inland water.—The extent of this precipitation on the land, of course, varies in different climatic regions, but the quantity of water precipitated in humid regions is enormous. In the United States, with a *mean annual rainfall* of about 30 inches, the total quantity of water falling upon the United States, including the water surfaces, has been estimated as 215,000,000,000,000 cubic feet. Expressed in units of weight, this would be approximately 6,718,750 times a million tons. Or, to put it in another way, the rainfall in the United States each year is about equal in volume to ten Mississippi Rivers. Of this enormous precipitation in the United States, over one-half is east of the 95th meridian.

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[12] *Commerce Year Book*, 1926, Vol. I, pp. 615, 616, 622.

[13] *Merchant Marine Statistics*, 1927, p. 67.

Of course, not all this great precipitation becomes finally a part of the inland water, for a considerable portion of it is soon evaporated. The amount of it which so disappears depends upon various factors, such as temperature, wind movement, vapor tension, altitude, nature of the surface, vegetation, and so forth. For the United States, McGee estimates that about one-half soon evaporates and so is almost directly returned to the atmosphere. He further estimates that perhaps one-sixth is consumed by the plants or goes far enough below the surface to join the *underground water,* the *subsurface water,* or as it is commonly called, the *ground water.* The remaining one-third, according to McGee's estimate for the United States, passes into the streams, rivers, and lakes, and finally, for the most part, into the ocean. The last two divisions, or the real inland water, then may be classified somewhat as follows:

INLAND WATER

A. Surface water.
    1. Impounded.
        a. Lakes and ponds.
        b. Reservoirs.
    2. Flowing.
        a. Rivers and creeks.
        b. Canals.
B. Subsurface water.
    1. Ground water.
    2. Between ground water and surface.[14]

Inland waterways used for navigation.—Lakes, rivers, and canals are much used for commerce and transportation. This is especially true in somewhat backward countries like Brazil, China, and Russia, which have great navigable rivers but not many railways developed. But great use is made of inland waterways, also, in advanced countries such as England, France, Germany, Holland, and the United States.

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[14] Bowman divides this underground water above the *water table* (top surface of the ground water) into two classes called *capillary water and hygroscopic water.* "Forest Physiography," p. 44.

Brazil, for example, has the wonderful *Amazon,* extending from the Andes to the Atlantic, a distance of 4000 miles, and discharging such a volume of water through its hundred-mile-wide mouth that the muddy waters of its powerful current are visible 200 miles out in the Atlantic. This great river, with only a 35 ft. fall in 2000 miles, has a channel depth of 200 ft. as far up as the mouth of the Rio Negro, and of 100 ft. that much farther up. Ocean-going vessels go up the Amazon to Iquitos, Peru, 2300 miles from the ocean, while steamers with but 14 ft. draft can go 480 miles beyond Iquitos. The Amazon has 14 tributaries as long as the Rhine, and one as long as the Mississippi. With these and innumerable smaller tributaries, the Amazon drains an area half as large as Europe. Up and down this river and its large tributaries, regular lines of steamers are constantly carrying out rubber, cocoa, Brazil nuts, cabinet woods, and other products of the region; and bringing in merchandise and supplies from other parts of Brazil and from foreign countries.

In Russia, the *Volga* is navigable for 2000 miles from its mouth to the shore of the Caspian Sea, the world's largest inland sea, or lake. The Volga is connected by canals with rivers emptying into the Baltic, the White, and the Black seas.

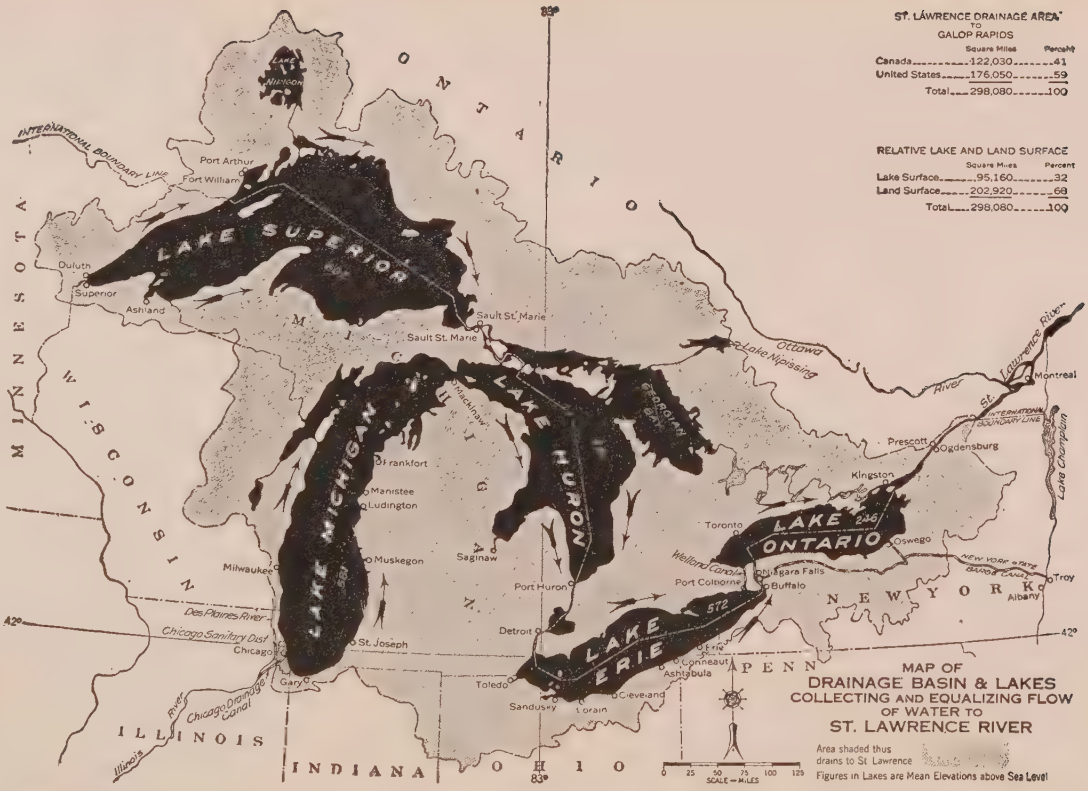
China, the world's most populous country, has the Yangtze its principal river, as long as and bigger than our own Mississippi. No other river in the world furnishes commerce and transportation to so many people as the Yangtze. Near its mouth is Shanghai, China's chief commercial port. Six hundred miles up this river is Hankau, a great inland city accessible to ocean steamships; while large river steamers ascend another 400 miles to the rapids to the 400 mile gorge that the Yangtze has cut through the mountain ranges that separate the plains of central and eastern China. The wide, fertile and populous plain, through which the Yangtze flows from the rapids to the delta at its mouth, is intensively cultivated and supports many cities and towns; while, above the gorge, the river serves the most populous and productive of China's 18 provinces, the province of Szechnan with its 40 or 50 million people. The trade of the upper Yangtze is handled by 8000 junks and 250,000 river men. The Hwang is another great commercial river of China, but it is not the important commercial artery that the Yangtze is. In fact, no other country has a river so vital to its commerce as the Yangtze is to China.

In Egypt the *Nile,* navigable for 2900 miles, is still the main artery of traffic. In India, the second most populous country of the world, the great Ganges River, whose broad and fertile valley contains nearly half the country's people, was the main highway of commerce and transportation until the English constructed the railroads. Since then, navigation has greatly declined on the Ganges.

In Germany, the *Rhine* has always been an important commercial artery, as also in Holland. Its importance to man is suggested by the 467 cities and villages that dot its banks. But the Elbe, the Weser, and a great system of canals also aid in providing Germany with a great system of inland waterways. So also may be cited the commercial importance of the Rhone, the Garonne, the Loire, the Seine, and the canals of France; and the Thames, the Mersey, the Clyde, and the Manchester Ship Canal of Great Britain.

In New York State there is the *Hudson,* used more for navigation than any other river in the United States, excepting possibly the Ohio River. Occupying a drowned valley, the Hudson is traversed by ocean tides for 170 miles to Troy, and its naturally good channel has been improved by the government so that ocean-going vessels can go far inland, while the largest of them can find anchorage within its mouth at the docks of New York City. The Mississippi has 16,000 miles of navigable rivers, being surpassed, naturally, only by the Amazon and its tributaries. Its use for commerce, once great, has declined since the advent of the railroads, but promises increased importance in the future. Altogether, the rivers of the United States include some 25,000 miles of rivers now navigated, and as many miles of streams that can be made navigable.

Besides these 50,000 miles of rivers we have over 2000 miles of *canals,* including the Erie Canal, the "Soo," and



ST. LAWRENCE DRAINAGE AREA TO GALOP RAPIDS

	Square Miles	Percent
Canada	122,030	41
United States	176,050	59
Total	298,080	100

RELATIVE LAKE AND LAND SURFACE

	Square Miles	Percent
Lake Surface	95,160	32
Land Surface	202,920	68
Total	298,080	100

Courtesy of Samuel S. Wyer.

Fig. 104.—Illustrating advantages of St. Lawrence Waterway. The Great Lakes are natural reservoirs covering one-third of the whole drainage basin, equalizing stream flow, and lessening the collection of silt in the St. Lawrence, thus increasing the ease of maintaining channels. The river is in the general direction of our greatest foreign commerce. River and lakes together reach far inland. Great power development is possible and in populous parts of territory where coal is scarce.

others; while along our Atlantic and Gulf coasts are 2500 miles of bays and sounds which can be connected by canals. These would total perhaps another thousand miles. Finally, we have the five *Great Lakes,* four of which we share with Canada. These lakes constitute the world's greatest inland waterway. Their combined length is 1410 miles, the four on the boundary being 1075 miles long. Including the St. Lawrence River, these lakes provide an inland waterway of 2000 miles from Duluth to the Atlantic. (See Fig. 104.)

In 1925, our inland waterways carried tonnage totaling 204,569,000 tons. Of this, there passed through the Detroit River alone, connecting Lake Huron and Lake Erie, over 90,400,000 tons. In 1926 the total tonnage on our inland waterways was 217,000,000 tons, an increase of 6% over 1925.[14]

During 1926, studies of the proposed improvements of the *Great Lakes-St. Lawrence* waterway were completed; and the United States St. Lawrence Commission concluded that there was imperative need for such a shipway to the sea, for the relief and development of the interior of the continent; and that the shipway should be constructed on the St. Lawrence route, provided that suitable agreement can be made with Canada. The joint board of engineers reported that the scheme from an engineering viewpoint is practicable, and that probably in seven or eight years from the time of beginning active work, the waterway could be opened to navigation. Early in 1927, the U. S. Dept. of Commerce reported the results of its economic survey of the Great Lakes-to-ocean waterway projects, and this was favorable to the St. Lawrence route. It is to be hoped that Canada and the United States can get together, and that this projected great improvement in North America's unrivaled inland waterway may soon become a reality.

Inland water utilized for fish and minerals.—Most of the world's supply of fish comes from the ocean, where such great fishing grounds as those of the Newfoundland Banks and the North Sea are the bases of great fishing industries. However, inland waters, especially those of large countries like the United States and Russia, not only offer opportunity for much fishing for sport and recreation, but also support extensive fishing on a commercial basis.

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[14] *Commerce Year Book,* 1926, Vol. 1, p. 609. *Commerce Year Book,* 1928, Vol I, p. 613.

In the United States, the Great Lakes and many smaller lakes yield *whitefish,* trout, herring, and so forth, the most valuable of which as to quantity are the whitefish. Then, centered in Chesapeake Bay are *oyster* fisheries of great value, and on the Pacific coast particularly the *salmon* catch, the basis of a great canning industry, is in part at least attributable to inland waters. Many of the salmon are caught in rivers notably the Columbia, which the fish ascend to their spawning grounds. In Russia, the fisheries of the Caspian Sea and rivers like the Volga and the Don are of great importance and value particularly because of the abundance of *sturgeon* in those waters. The most important fishery import from there is caviar, or sturgeon roe, prepared as a condiment.

Minerals are not found to any extent in fresh water lakes and rivers, but other inland waters often furnish salt, potash, peat, medicinal salts, and mineral waters, the last item running into an annual sale value of approximately $10,000,000 in the United States alone. Swamps sometimes supply peat, a sort of half-mineral fuel, and salt lakes are an important source of common salt, such as is obtained by evaporating the water of the Dead Sea and of Great Salt Lake, and in some instances, such as in various little lakes in western Nebraska, more valuable minerals, like potash, are thus obtained.

Inland waters as a source of water power.—In heavily timbered regions, streams are often used as an economical means to float logs from the forest to the saw mills, while water power, where sufficient rainfall and elevation are combined, is one of the most economical sources of energy. Water power developments on a large scale are already in use in favorable locations, such as the Alps in Switzerland, Italy, and France, the mountains of Norway and Sweden, the Southern Appalachians, and the Cascade Mountains in the United States. (Figs. 105 and 106.) Many others are in successful economical operation; as, on the Susquehanna River in Pennsylvania, the Dix River in Kentucky, and at Niagara Falls in New York, but as yet the developed water power from inland waters is only a small but increasing fraction of the possible water power. Thus the great dark continent of Africa, with its big rivers, as the Congo, the Niger, the Nile, and the Zambezi, rising on the high inland plateau in the region of heavy tropical rainfall, has enormous potential water power resources, but little is as yet developed. Africa is estimated to possess over 40% of the world's total potential water power.[15] (See Fig. 73.)

Photo by Hoyt, U. S. Geol. Survey.

Fig. 105.—Typical Power Scene.

In nearly all countries, most of the water power developed is used to generate electricity. Of the countries for which accurate data is available, the United States has the greatest extent of developed water power; Canada comes next; while Italy ranks third, followed by France, Norway, and Switzerland in power actually developed. The use of water power is continually growing. For example, in public utility electric plants, including electric railways, in the United States as

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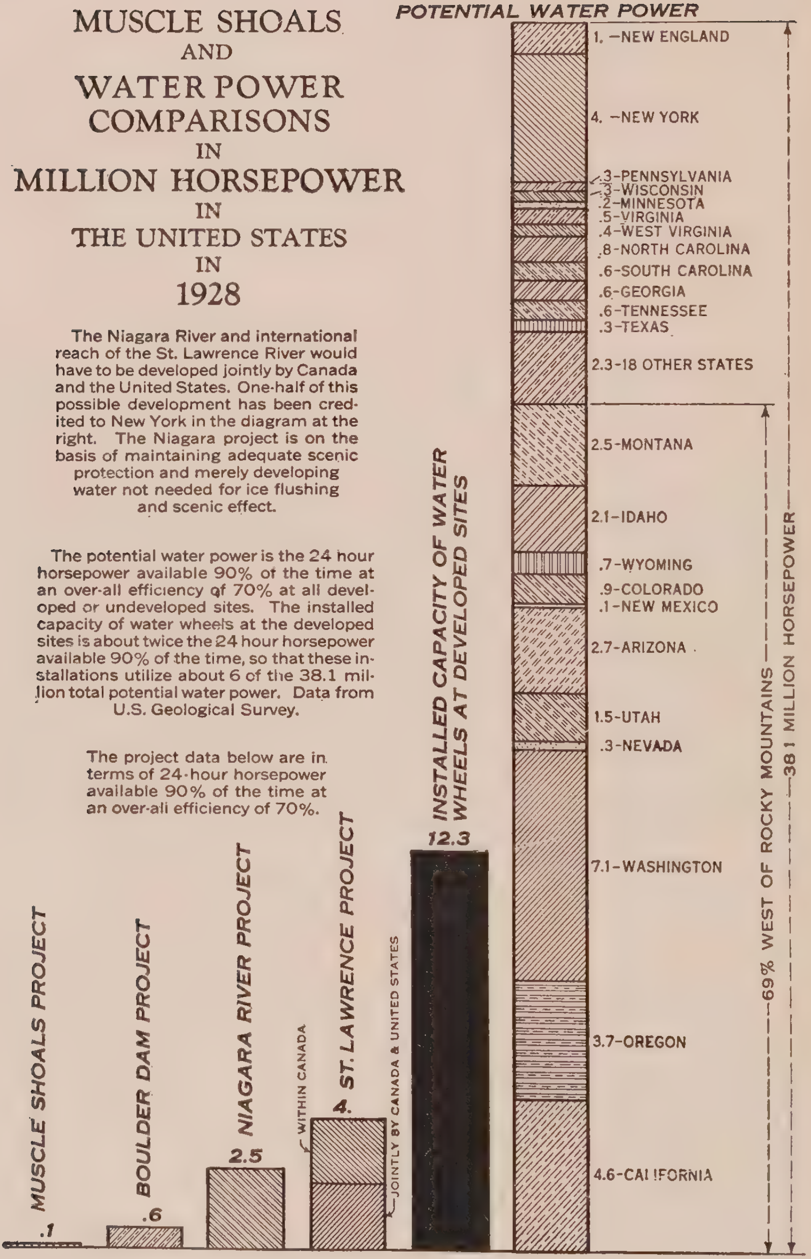
[15] *Commerce Year Book*, 1928, Vol. I, p. 715, gives for Africa potential water power of 190,950,000 horse power, with only 13,680,000 h. p. developed.



MUSCLE SHOALS
AND
WATER POWER
COMPARISONS
IN
MILLION HORSEPOWER
IN
THE UNITED STATES
IN
1928

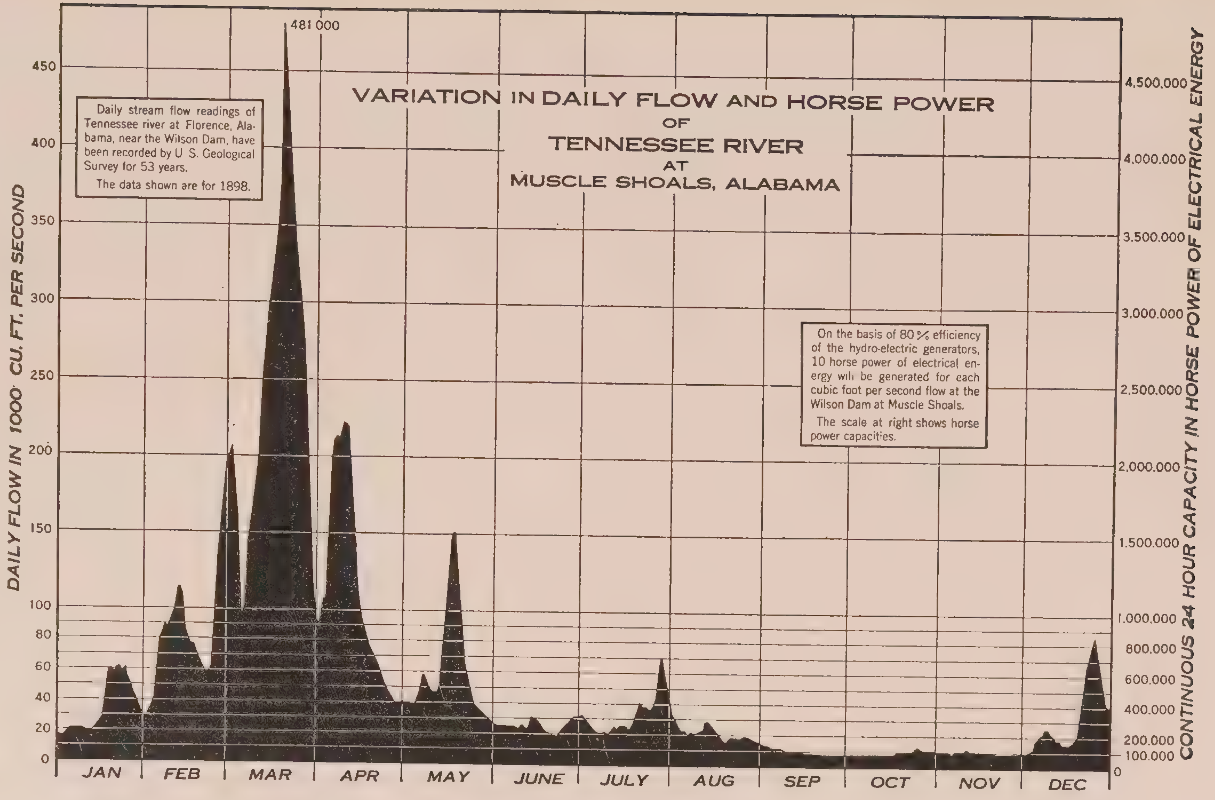
The Niagara River and international reach of the St. Lawrence River would have to be developed jointly by Canada and the United States. One-half of this possible development has been credited to New York in the diagram at the right. The Niagara project is on the basis of maintaining adequate scenic protection and merely developing water not needed for ice flushing and scenic effect.

The potential water power is the 24 hour horsepower available 90% of the time at an over-all efficiency of 70% at all developed or undeveloped sites. The installed capacity of water wheels at the developed sites is about twice the 24 hour horsepower available 90% of the time, so that these installations utilize about 6 of the 38.1 million total potential water power. Data from U.S. Geological Survey.

The project data below are in terms of 24-hour horsepower available 90% of the time at an over-all efficiency of 70%.

Courtesy of Samuel S. Wyer.

Fig. 106.



VARIATION IN DAILY FLOW AND HORSE POWER
OF
TENNESSEE RIVER
AT
MUSCLE SHOALS, ALABAMA

Daily stream flow readings of Tennessee river at Florence, Alabama, near the Wilson Dam, have been recorded by U. S. Geological Survey for 53 years.

The data shown are for 1898.

On the basis of 80% efficiency of the hydro-electric generators, 10 horse power of electrical energy will be generated for each cubic foot per second flow at the Wilson Dam at Muscle Shoals.

The scale at right shows horse power capacities.

Courtesy of Samuel S. Wyer.

Fig. 107.

shown by the Census, of the total horsepower of prime movers installed, about one-fourth was operated by water power in 1922, and three-fourths by fuel power. On the other hand, twenty years before, in 1902, the hydroelectric equipment represented only 15% of the total, but in 1926 the proportion developed by water power was 35.3%. (See Fig. 101.)

Distance from the point where the current is to be used, the first cost of harnessing the water power, and irregularity of stream flow are factors limiting its development. (See Fig. 107.) While the United States still has immense potential water power undeveloped, its production is thus limited to favorable geographic regions, therefore fuel will probably continue, for some time, to be the chief source of power used. The following table shows the estimates of potential and developed water power for certain countries for which statistics were available in 1926.[16]

WATER-POWER ESTIMATES FOR CERTAIN COUNTRIES, 1926

Country	Total Resources Horsepower	Amount Developed Horsepower
World Total	454,000,000	33,000,000
United States	35,000,000	11,721,000
Canada	18,250,000	4,556,000
Brazil	25,000,000	500,000
Italy	6,000,000 (1924)	2,300,000
Sweden	8,000,000	1,350,000
France	5,400,000	2,000,000
Switzerland	2,500,000	1,850,000
Norway	9,500,000	1,900,000
China	20,000,000	1,650
India	27,000,000	200,000
United Kingdom	850,000	250,000
Belgian Congo and Belgian Mandate	90,000,000	250
French Congo	35,000,000	0

Water for agriculture and irrigation.—Since plants constitute the basis for agriculture, and water is a necessity for plant life, it follows that a very close relation must exist between agriculture and water supply. All are familiar with the importance of rainfall to agriculture, but it is by evaporation that water vapor gets into the air and thus is the source of rainfall. Evaporation is significant to agriculture in other ways. Where evaporation is high it usually takes more rainfall for grass and crops, than where the evaporation is less. Such a result of evaporation differences is strikingly illustrated by the conditions in various parts of the Great Plains of the United States and Canada. This is well brought out for example, in the following paragraph from Buechel:[17]

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[16] *Commerce Year Book*, Vol. II, p. 715.

> The Edwards Plateau section in Texas has a rainfall of 20 to 25 inches; its native vegetation is mainly mesquite and desert grass savanna and the main industry is grazing. The High Plains country of the Panhandle has a rainfall of 15 to 23 inches; but the native vegetation is short grass, chiefly buffalo and grama, and the main industry is grazing with dry farming. Farther northward, where evaporation is less, as in eastern Montana, a rainfall of 10 to 15 inches produces a typical short-grass vegetation. Still farther north in Canada, 10 to 15 inches of rainfall gives a zone of tall grasses and dark colored soils, this belt being the center of wheat production in western Canada. Beyond the tallgrass region, to the north with a rainfall of only 10 to 12 inches, is a zone of coniferous forest which, taken as a whole, is a non-agricultural region owing to its climate, topography, and soil.

The great quantity of water needed by plants.—The amount of water needed by growing plants is much greater than the amount of dry vegetable substance produced. Generally it is from 50 to 900 times the weight of the dry substance. Water is taken up from the soil by plant roots, is circulated through the plant, and most of it is vaporized or " breathed " out, so to speak, from the pores of leaf and other vegetable surface, in the process, called by botanists *transpiration*. In this way, a considerable quantity of the subsurface water finds its way back into the air. That it amounts to a large part of the annual rainfall in many parts of the temperate zone is indicated by the following figures showing the normal seasonal transpiration for the north central part of the United States.[18]

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[17] Buechel, "The Commerce of Agriculture," p. 33.

[18] Meyer, "Elements of Hydrology," p. 262. These figures mean, that many inches depth of water over the whole area occupied by each form of vegetation.

Grains, grasses, and agricultural crops	9 to 10 inches
Deciduous trees	8 to 12 "
Small trees and brush	6 to 8 "
Coniferous trees	4 to 6 "

Since much of the precipitation is evaporated very quickly and a large amount is thus utilized in plant transpiration it follows that unless there is considerable rainfall there may be little or none left of the *run-off,* or that part of the water which by direct surface flow or by seepage finds its way into streams and so finally back to the ocean. In a very general way, it may be said for the United States that the demands of evaporation and transpiration require from about 15 to 25 inches of precipitation per year. Consequently, as some portions of the United States do not have that much annual rainfall it comes about that sufficient water for the successful growth of agricultural plants can be obtained only by artificial means, that is, by irrigation. The same is true in arid and semiarid regions elsewhere.

Importance of irrigation.—Unfortunately, *in the arid regions* where agriculture can be carried on only by irrigation, there is likely also, from the very nature of things, to be a rather limited source of supply of water for irrigation. As population increases these water resources become more and more valuable and lest they be monopolized for the benefit of a few, or be wasted, methods of control and conservation become important.

Irrigation is advisable in agriculture for the best results whenever there is less than 20 inches, or when there are frequent droughts during the season for growing the crop. It was practised by the ancients thousands of years before Christ, for example, in Egypt, Assyria, Persia, India, and China. Some of those countries still have very large areas under irrigation. In *India,* which leads the world now in the extent of its irrigated areas, there are some 50,000,000 acres under irrigation, three times as much as in the United States. In *Peru,* large irrigated plantations produce much of the sugar of the country. The sugar crop makes up half the total value of the exports from the country, and if they could get sufficient

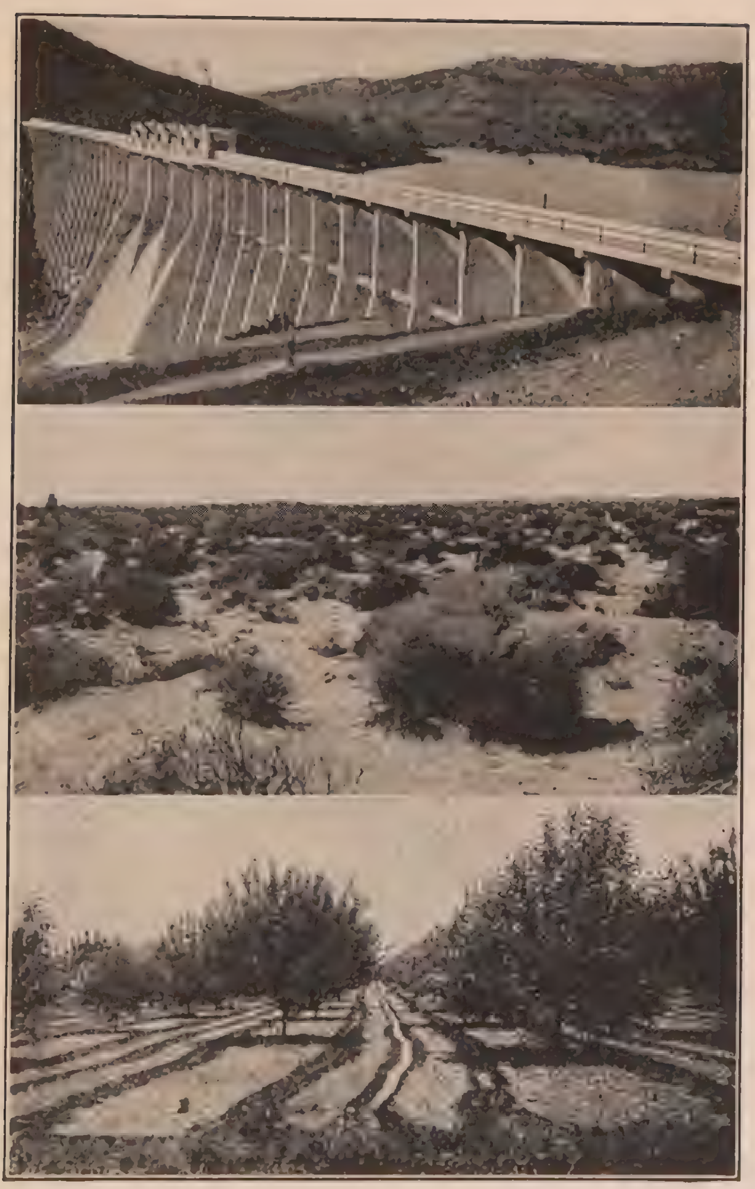
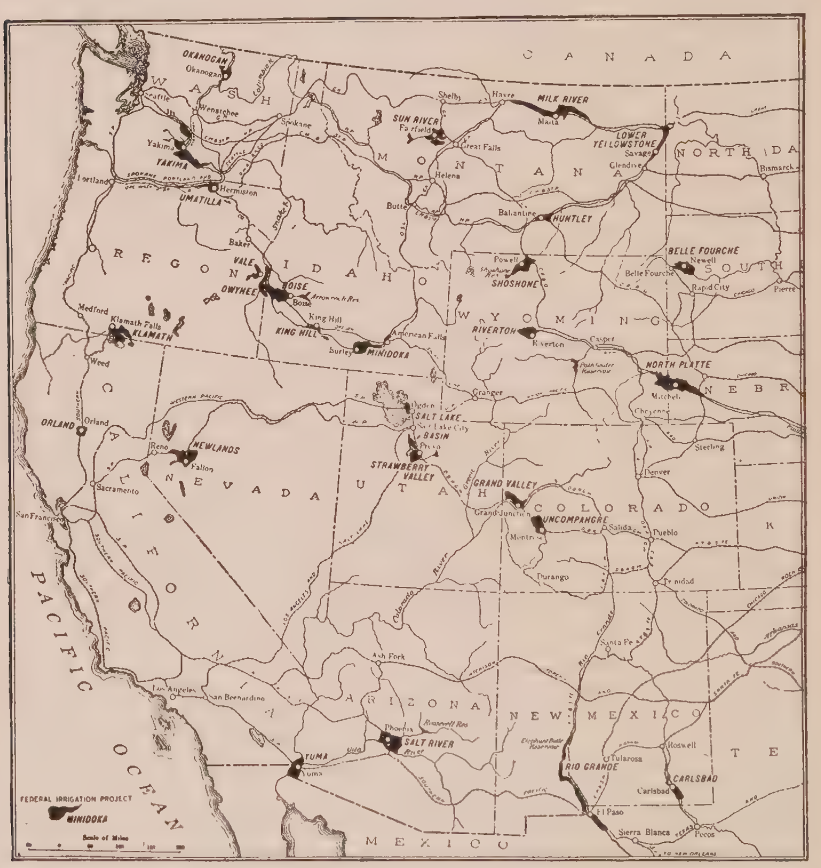


Fig. 108.—The Utilization of Water for Irrigation.

Upper.—The storage dam of the Orland project, California.
Middle.—The desert. (Photos by the U. S. Reclamation Service.)
Lower.—The desert reclaimed. (Photo by U. S. Bureau of Agricultural Economics.)

water for irrigation much more of both these products (sugar and cotton) could be raised. Irrigation is practised also in Argentina, Spain, Italy, Egypt, China, Australia, the United States, and elsewhere.



Map by U. S. Reclamation Service.

Fig. 109.—Irrigation Projects in the United States.

Its importance is very great, for it makes available a great resource which otherwise would be of little value. *Irrigated lands often have relatively high values.* Several reasons may be given for this: (1) Arid lands are likely to be rich in the mineral elements necessary for plant growth, as these have not been leached out of the soil by rainfall; (2) just the right amount of water needed for the crop growth can be furnished by irrigation, and at the time when it is needed; (3) in many irrigated regions, as in the warmer parts of the United States, two or more crops can be raised on the same land in a single year; (4) as the water is turned over the land and only occasionally is there much precipitation, there is but little erosion. In the United States, the crops raised by irrigation include grains, hay, alfalfa; truck, as onions, potatoes, beets, peas, lettuce, and other vegetables; fruits, as apples, peaches, prunes, oranges, and lemons; berries and nuts, such as walnuts, pecans, and so forth. A division of the United States Government, the Bureau of Reclamation, is devoted to the utilization of arid lands by irrigation. (See Figs. 108 and 109.)

Other uses of inland water.—Besides the importance of lakes in modifying temperatures, thus facilitating the growing of grapes and other fruits susceptible to the dangers of frosts; inland waters are an important source of moisture as much evaporation takes place from their surfaces. Then, too, they contribute much to the recreation, health and happiness of large numbers of people. (See Fig. 110.) Mineral springs, such as those of Carlsbad, and the Hot Springs of Arkansas and Virginia are resorted to by hundreds of people every year. Glaciers and geysers annually contribute to the pleasure and inspiration of thousands.

The importance of lakes and rivers as pleasure resorts is evidenced by the thousands of summer cottages along the shores of hundreds of lakes and rivers as well as by the many bathing beaches, dancing pavilions and amusement parks which mark these same shores in increasing numbers each year.

Of course inland waters have *some disadvantages.* For example, they often are barriers to travel and transportation. It takes time and energy to go around a lake, or up or down a stream to find a ford; and it costs money to build bridges and culverts or operate ferries. Then, too, floods are often destructive to life and property and thousands of people are thus annually rendered homeless, while thousands of dollars are required in flood prevention and reparations. (See Fig 59.)

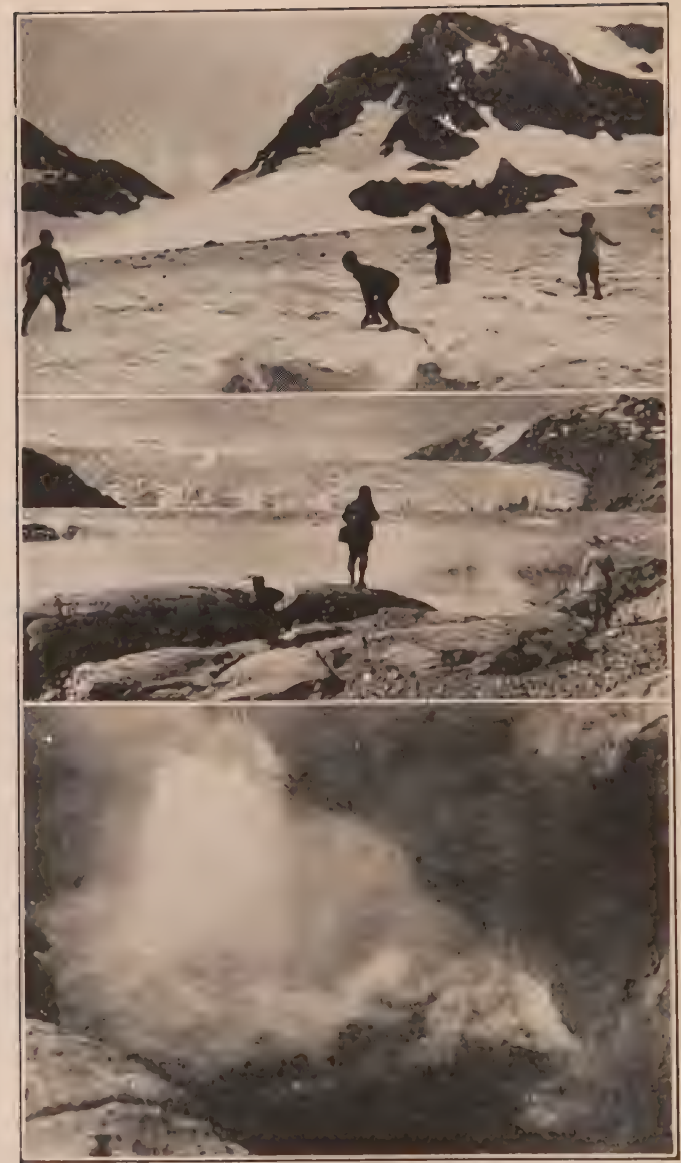


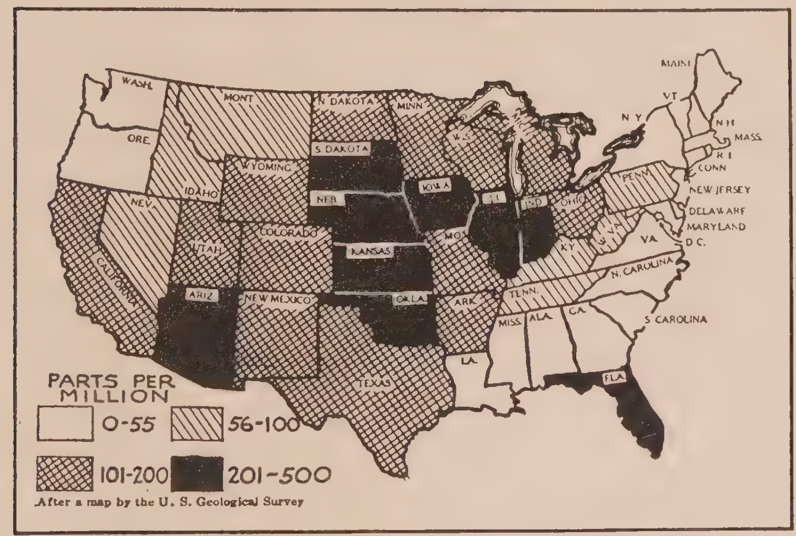
Fig. 110.—Glaciers and Geysers Useful for Recreation.

Upper.—Tourists snowballing on the Lyman Glacier, Chelan National Forest, Washington. (Photo by courtesy U. S. Forest Service.)

Middle.—Chenego Glacier, Prince William Sound, Alaska. (Photo by Moffit, U. S. Geological Survey.)

Lower.—Pohuta Cauldron, in the famous geyser district of North Island, New Zealand. (Photo by courtesy of the New Zealand Government.)

But all these disadvantages, disutilities, as the economists might say, of inland water are far outweighed by just one utility of this great natural resource; namely, its use as *water supply*. This is, most will agree, the highest use of inland water. If there arises a conflict between its use for water supply and its use for any other purpose, such as water power or irrigation, precedence should be given to water supply. Water supply includes the use of water both for domestic purposes and for industrial purposes. Water for water supply comes both from surface sources, as rivers, canals, lakes, and reservoirs; and from underground water, as in the case of wells. Purity and quantity are two prime considerations to be kept in mind in connection with water supply.



After a map by the U. S. Geological Survey

Fig. 111.—Hardness of Water Supply by States.

Benefits of soft water.—Another geographical factor related to a good water supply is the degree of hardness of the water. Soft water is now considered almost as much a public necessity as water free from sediment and bacterial poisons. Hardness in water, due chiefly to calcium and magnesium dissolved from rocks and soil, is closely related to the underlying rock of the region. Thus the United States may be divided into "hard water" states, whose waters average in hardness from 200 to 500 parts per million, and "soft water" states, where the hardness averages 55 parts or less per million. Most of the hard water states get their water supplies largely from wells. Next to this is an intermediate group extending from Ohio north and then west to North Dakota, and from Wyoming to Texas, which depends more on surface water supplies and less on wells.

Taking the hardness out of water is coming more and more to be considered a municipal duty owed to the public. The saving in soap alone is estimated to average three times the annual cost to the municipality of softening the water at the filtration plant. Other savings come from decreased laundry bills, fuel-heating bills, pipe-cleaning bills, plumbing bills, and various others. A city seeking manufacturing industries is handicapped, too, if its water is hard. (Fig. 111 shows by states the average hardness of water furnished by public supply systems of cities.)

CHAPTER XV

BIOLOGICAL ENVIRONMENTAL ELEMENTS

Introduction.

Plants and animals.—The biological elements of man's environment include plants and animals. Like man they represent a part of the organic world. Thus, a more intimate reciprocal relationship exists between man and the biological elements, than between man and the inorganic elements, such as climate, lands, and water. Also, like man, plants and animals are dependent upon the natural environment for their existence. The nature of the surroundings of plants and animals appears to be reflected more or less in the character of these living forms. This association of plants and animals to their climatic and physiographic environment is called "adaptation." It is a phenomenon of considerable importance in

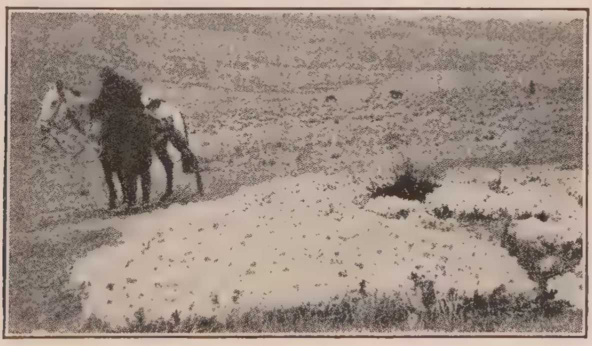


Fig. 112.—Clump of polar bear cacti at elevation of 14,000 feet in the Andes of Peru. At a distance, a plain dotted with such clumps looks as if it were covered with grazing sheep. All cacti are highly specialized plants, adapted to live in places where there is very little moisture; but this cactus must be still more specialized, for it not only has to face the absence of water in the soil and air, but the effect of a high altitude, where the cold is intense at night but the sun excessively hot by day. The cactus here shown seems to be as well fitted for its environment as the polar bear for the ice floes. (Photo by courtesy of O. F. Cook.)

the interpretation of plant and animal requirements as well as an index to environmental circumstances. (See Fig. 112.)

Index value of plants and animals.—The plant and animal kingdoms are thus indicators of physical environmental conditions. They represent a key to the nature of these environmental elements, and to many of the characteristics of man's distribution and activities. The living forms of plants and animals reveal the character of the present forces of the world, while plant and animal remains or fossils have kept a record of the activities of the past. This environmental index value of the organic elements is attributed to the fact that nearly all plants and animals seem physically fitted for the place where they live.

Adaptation.—Regions of similar physical environmental conditions are usually regions of similar plant flora and animal fauna. However, plant and animal habitats, alike in character, do not always have the same plant or animal species or the same abundance of living forms. The presence or absence of barriers, either past or present, may have retarded or assisted plant and animal migration. Man, also, is responsible for many changes in the world's plant and animal exhibits. In general, regions of extreme conditions of natural environment, such as deserts and polar lands, have the most striking degree of plant and animal adaptation.

In *desert* regions, the perennial plants are protected against an excessive loss of moisture in having leaves and stems that are coated with wax, dense hair, or a thick epidermal layer. The roots extend to great depths or they may be near the surface to utilize the moisture from light rains or dew, thus obtaining by absorption the maximum amount of water available. The *arctic* flora is scant and similar in character. Only those plants can prevail that are covered with snow during the winter, if the loss of moisture by transpiration is high. The absence of trees in the polar lands is not solely due to a low temperature but rather to a high rate of transpiration. For example, the coldest regions of the earth are the forest lands of Siberia. In a similar manner, the thickly haired or fur-coated animals of the polar regions, and the presence of thick- and scaly-skinned animals of desert regions, illustrate the principle of adaptation. Animals, however, in having the power of locomotion, show less adaptation than plants which are relatively stationary in so far as their own power is concerned.

In the humid-temperate and tropical belts, the grasslands and forests are the broadest examples of adaptation, but within these belts there exist complex and diversified forms of plant and animal life.

Plants as a Geographic Factor.

Geographic importance of plants.—The reciprocal relationship between plants and man is a geographic matter of preëminent importance. Man is dependent upon the plant kingdom for his clothing, his home, his transportation, and many of his pleasures; in fact, for his very existence. With somewhat the same degree of reliance, many plants owe their life and widespread diffusion to man's efforts. In fact, plant and man are so closely related that it is difficult to think of one not being influenced by the other.

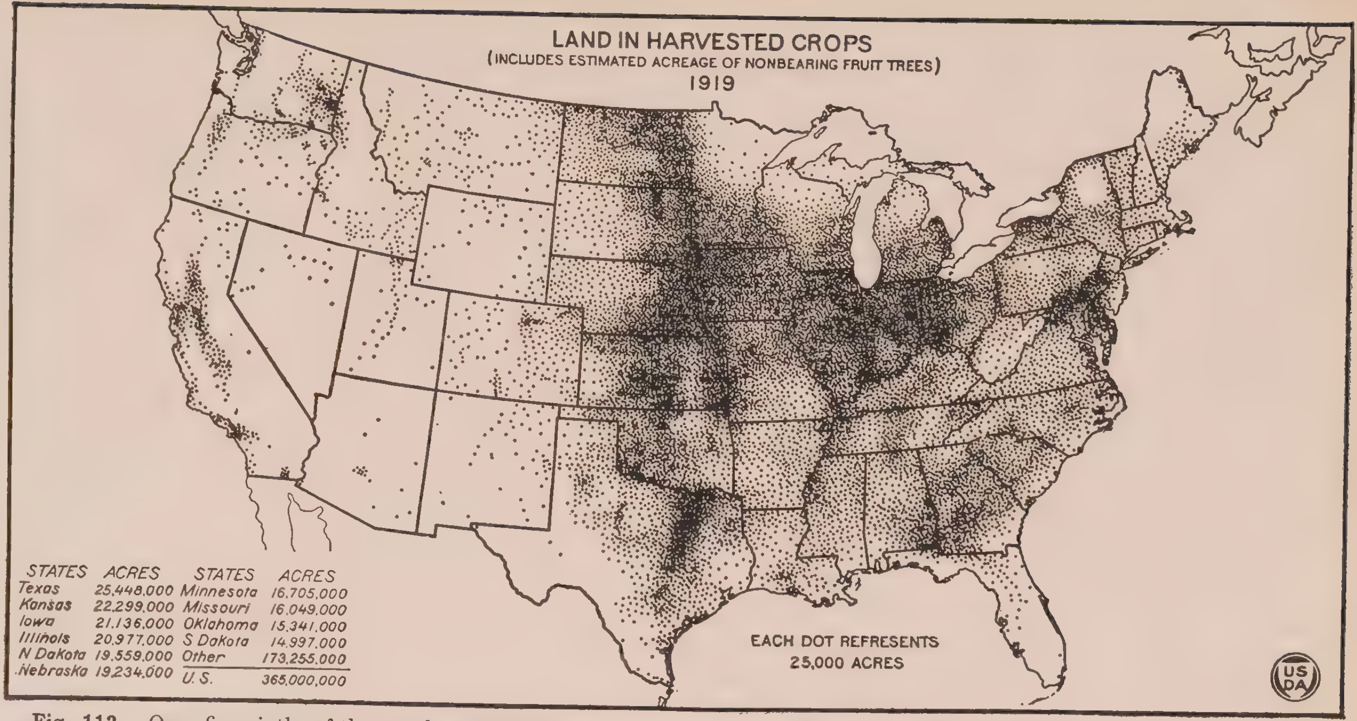
Man's distribution in relation to plants.—The human life zone, as designated by Ratzel, a distinguished European geographer, coincides with the extent of vegetation on land in lying between latitudes 80° North and 55° South. A map showing this relation between the distribution of plant and man, further reveals that in the hot *rainy tropical belt* the vegetation is so dense that human beings can exist only with difficulty. As a consequence, in this belt population is very sparse, averaging less than one inhabitant per square mile except in East India. *In the polar lands,* the vegetation is very scant and the number of persons per square mile is about one. In a like manner, the *desert regions* are sparsely populated and often void of both plants and man. The *temperate belts* are not only the richest in plant products of the world but also the regions of the densest population and of the highest civilization.

A more detailed analysis of the *world's distribution of population and vegetation* shows the following relations: (1)

that centers of concentrated population are accessible to areas of useful plant products (see Fig. 113); (2) that there are areas of relatively dense population in regions of highly specialized plant culture; and (3) that the lands of scattered population are often associated with regions of extensive agriculture or regions of dense forest growth. Large cities develop in regions of available plant products; because, first, an abundance of food is required in areas of concentrated population, and second, plants are the principal sources of food. Hence, cities such as Chicago, Cincinnati, and Minneapolis of the United States owe their development partly to their proximity to fertile plains where plants can be successfully produced. New York, Philadelphia, and Baltimore are other examples of cities favorably located with respect to domestic as well as foreign supplies of plant products. Within thickly populated areas, plants serve not only as food products but also as raw material for the manufacturing industry.

The *concentration of people in regions of intensive plant culture* is well illustrated by the cotton plantation communities of southern United States, the coffee " fazendas " (large landed estates) of Brazil, the banana plantations of Central America, the henequen industry of Yucatan, the rubber plantations of the East Indies and Strait Settlements, the sugar plantations of Cuba, and the fruit industry of California. Here human occupation is governed by important commercial crops that radiate their influence to nearly all peoples of the world. The business of producing, transporting, and manufacturing these plant products as well as innumerable others into finished foods, clothing, and other human necessities constitutes the major activities of the world.

Sparse populations. Nearly all of the peoples of the earth who are represented on a population map as being scattered or away from group settlements are dependent directly upon plants for food and occupation. The wheat and the grazing industries are examples of human activities conducted over large areas of land in proportion to the number of inhabitants. The work of securing forest products is another human activity that is carried on by relatively few persons in



STATES	ACRES	STATES	ACRES
Texas	25,448,000	Minnesota	16,705,000
Kansas	22,299,000	Missouri	16,049,000
Iowa	21,136,000	Oklahoma	15,341,000
Illinois	20,977,000	S Dakota	14,997,000
N Dakota	19,559,000	Other	173,255,000
Nebraska	19,234,000	U. S.	365,000,000

Fig. 113.—Over five-sixths of the crop land is in the humid eastern half of the United States, and nearly two-thirds is concentrated in a triangular-shaped area, the points of which are located in western Pennsylvania, central Texas, and north central North Dakota. In this area, which includes only about one-fourth of the land of the United States, are produced four-fifths of the corn, three-fourths of the wheat and oats, and three-fifths of the hay crops of the Nation. No region in the world of equal size affords so favorable natural conditions for the growth of corn, and few regions possess so favorable conditions for the culture of the small grain and hay crops. (From the Yearbook of the U. S. Dept. of Agriculture, 1923, O. E. Baker.)

comparison to the size of the area under occupation.

Effects of the plant kingdom on human activities.—There are innumerable ways in which man's activities are benefited as well as retarded by vegetation and its products. Some of these geographical relationships may be discussed under such topics as "Plant Industries" and "Commerce of Plants." Limited space permits only a brief treatment of these subjects in this text.

Plant industries.—The work of *providing food* is man's greatest occupation. It concerns not only the production of plant and animal products but also their transportation, their preparation for food, and their marketing. Nearly all food is furnished by plants as they alone, with the assistance of sunlight, have the power of changing into food products, the materials found, as air, soil, and water. True, not all food does come directly from plants, but they are the indirect source of supply; because animals, the other source of food, feed upon plants. Nevertheless, the greater percentage of all food consumed by man comes directly from plants. The Eskimo is one exception as the larger part of his food represents animal products. It has been said that the typical American secures sixty-one per cent of his growth and force elements from cereals, fruits, and vegetables, while only thirty-one per cent comes from meat and dairy products. Probably the outstanding vegetarians of the world are the natives of India, who depend very largely upon rice for their daily sustenance.

The amount and kind of *plant food consumed* by the people of the world varies considerably with the major climatic belts and, to some extent, with the types of climate. The polar regions may be considered as void of either stable plant food or permanent human occupation. The lichens, mosses, water plants, grasses, and dwarf willows, and birches of the tundra lands offer little food for man. However, they serve man indirectly as they constitute the only food for the valuable Arctic animal, the reindeer or American caribou.

The inhabitants of *the temperate belts* enjoy a great variety of plant foods. The most important are the *cereals;* such as wheat, barley, oats, rye, rice, corn, millet, and sorghum.

Their very name indicates the value attached to them in historic time. They are named after the goddess Ceres, as the Romans called her, the patroness of agriculture and all fruits of the earth. *Wheat* is by far the most universal crop in these temperate regions and its importance is growing rapidly as the aristocrat of the cereals. Rye and barley are used more extensively in the colder regions of the temperate belts. Barley is also grown in the warmer parts as it adapts itself well to a warm, dry climate. *Corn* is used as an animal food more than as a part of the human diet.

Potatoes represent another important temperate crop and are used through the middle latitudes of the temperate belts. Europe produces, on the average, about ninety per cent of the world's potato crop. It has been referred to as the poor man's friend and the greatest public servant in the world.

Tropical plant foods.—In the tropical belt, the major food crops are rice, corn, beans, and cassava. *Rice* is master of all as more than one-half the whole population of the world subsists, to a great extent, on rice. Japan, China, India, and East India, regions of dense population, are decidedly dependent upon rice for their existence. *Cassava* or mandioca may be considered the Irish potato of the tropics. The yield per acre is high and it has proved an economical crop to grow. It grows in the form of a root which needs little attention in its stage of cultivation. In the United States we think of cassava as a source of tapioca but in South America, India, and other tropical countries it is used in nearly as many ways as the temperate dwellers use both potatoes and wheat. (See Fig. 114.)

Sugar is another crop grown in both the temperate and tropical regions but the production is far greater in the tropical countries, such as Cuba, Java, India, and Porto Rico. It represents a commercial crop that reaches a greater number of homes than any other single food product. *Fruits* of untold varieties are produced in both the temperate and tropical belts, such as oranges, grape fruit, grapes, lemons, pears, apples, prunes, apricots, and bananas. Many of these fruits are as much a part of the human diet as wheat, rice or potatoes.

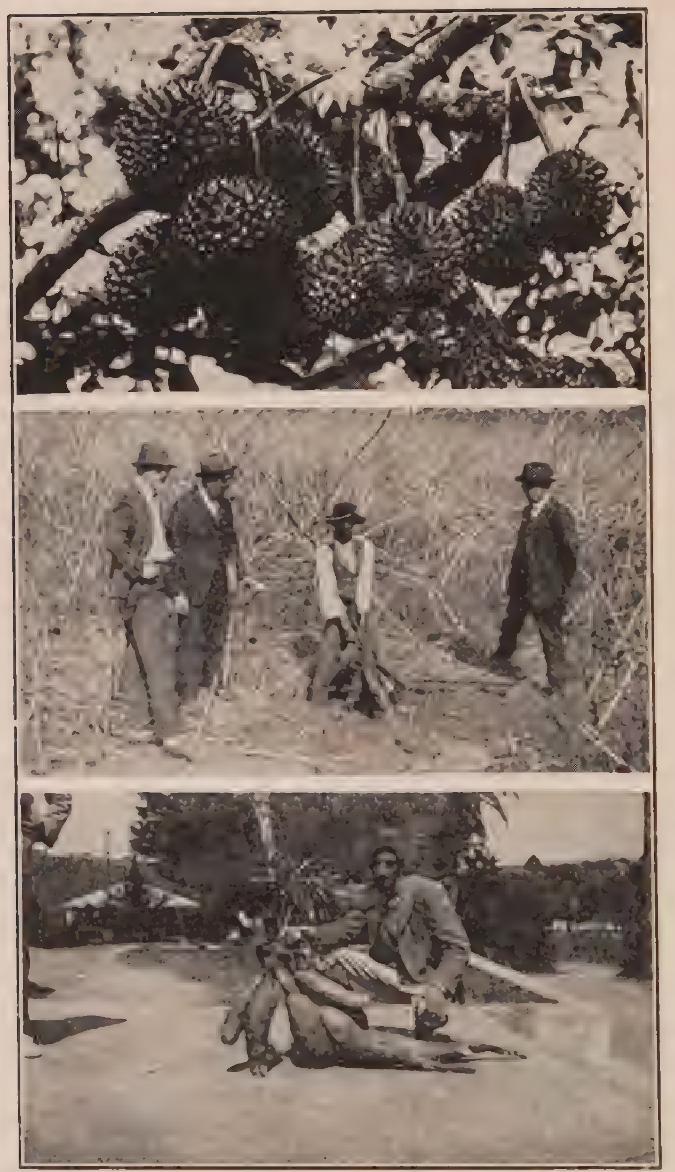


Fig. 114.—Tropical Fruit and Vegetables.

Upper.—Dorian, a native fruit popular in Singapore and the East Indies.
Middle.—Cassava plantation, Brazil. The roots are dug up with a hoe
Lower.—Roots of one cassava plant.

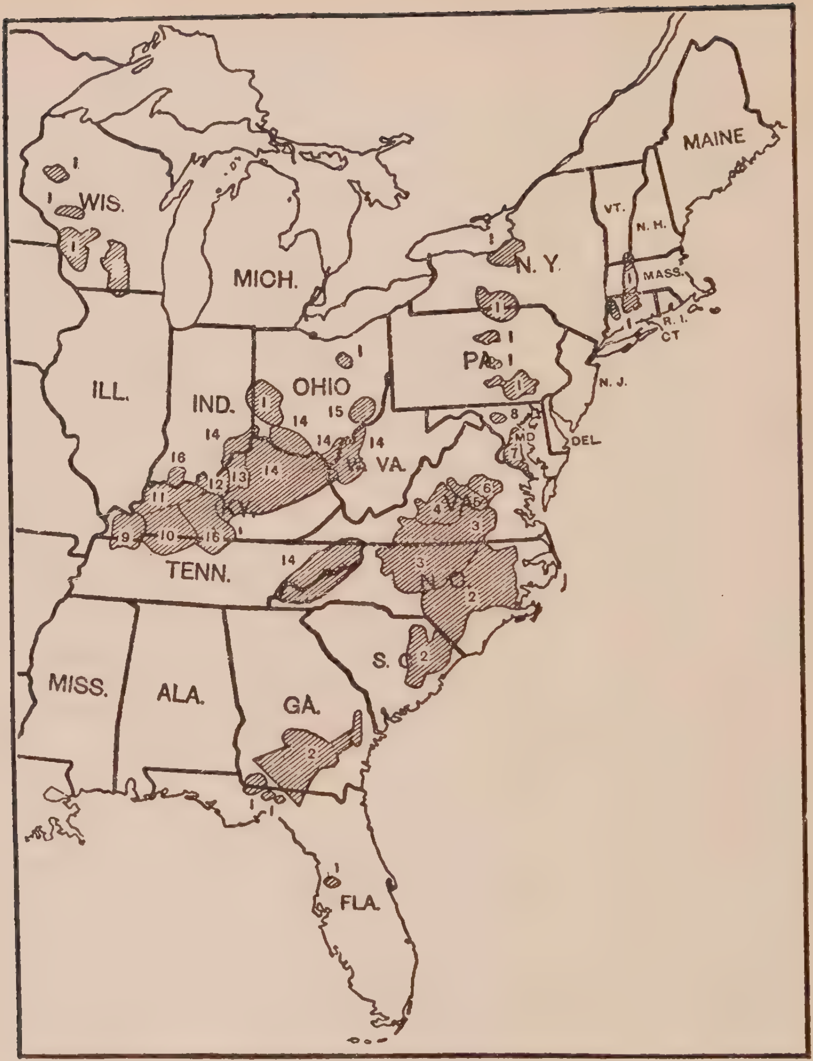
They are no longer looked upon as luxuries. *Coffee, tea,* and *cocoa* or cacao are other commercial crops that may be recognized as human requirements. They are grown primarily in the tropical lands. (See Fig. 46.)

Secondary industries utilize plants.—Many of the food products must be further treated before they can be used as food. Thus there has developed a group of manufactures which in the United States leads all other manufacturing in value of products. These *plant food industries* include such as the flour mills, sugar factories, coffee curing and roasting factories, and plants preparing cereal products. It can be said that the plant products provide the greater portion of the *raw material* used in manufacturing. Generally, the first type of manufacturing to start in any country is that based upon the utilization of some raw plant product.

The plant world is also the source of nearly all the material which man uses for *clothing.* It includes cotton, silk, and linen. The warm humid-temperate regions, and parts of irrigated deserts are the principal cotton-producing regions. The manufacturing of cotton is conducted primarily in regions of dense population in the temperate lands. In recent years, a product called artificial silk or rayon has been made from wood, which adds another important use of plant products. Linen is manufactured in the British Isles and the United States from flax grown in India, Russia, and Belgium.

Tobacco growing and manufacturing are other industries dependent on *man's desire for a plant product.* (See Fig. 115.) Then too, the material used in constructing, furnishing, and heating homes comes largely from the plant kingdom. The lumber industry and the wood pulp industry, with all of their ramifications, provide products and labor for millions of people. The utilization of coal, petroleum, and gas is an illustration of man's dependency upon plant life of the past, as these fuel materials have developed from plant remains. In reality there is scarcely one human activity that is not in some way related to plant life or its products.

Commerce and plants.—In the early centuries, man was able to gather or grow the plants that he needed. The ma-



From Bur. of Census. Bull. 165 (1929), *U. S. Dept. of Commerce.*

Fig. 115.—Localities producing the several types of tobacco in the United States, 1928. Shaded portions indicate approximately extent of the several districts, which are numbered to correspond with explanation: (1) Cigar leaf. (2) New belt bright or flue cured. (3) Old belt bright or flue cured. (4) Virginia dark open-fire-cured shipping tobacco. (5) Black or olive stemming. (6) Sun and air cured manufacturing. (7) Maryland, southern. (8) Maryland, upper county or bay. (9) Paducah dark fired district. (10) Clarksville and Hopkinsville dark fired district. (11) Stemming tobacco dark fired district. (12) Green River dark air cured district. (13) Scattered Burley. (14) Burley. (15) Eastern Ohio export (spangled and Burley). (16) Southern Kentucky and upper Cumberland and southern Indiana (one-sucker type).

terial for food, clothing, and protection could be obtained within his immediate surroundings. Even to-day, there are tribes or groups of people living in the interior of South America and on the West Coast of Africa who are dependent upon the plant and animal products of their limited environment. But this is only true of backward, inaccessible countries. For as the complexities of mankind increased, it became necessary to obtain many of the essential products from more distant fields or lands. Thus, a *system of exchange* arose by which one group bartered their products for the commodities possessed by others. This business of exchange of plant products and other materials had obtained a high degree of development before the Christian era. The Carthaginians, the Romans, the Greeks, and the Venetians traded throughout the continent of Europe, Northern Africa, and the Near East; and some had reached the shores of India to make known the wealth of spices, " the gold fruit " of the early ages.

During the Middle Ages and up to the 16th century, *spices* played a very important part in the history of commerce. In fact the geography of the world has been greatly modified as a result of the competition for the possession of spices. The Portuguese, the Dutch, and the English carried on intensive struggles to secure a monopoly of the spice trade of India and East India. Great efforts were made to establish colonies in what were then distant lands. The Dutch and the English were successful and as a result these kingdoms have such valuable possessions as the Strait Settlements, Java, Sumatra, and other East Indian lands, the regions of our principal supply of rubber and tin.

The exchange of commodities between tribes, communities, states, and nations has developed into one of man's major activities, and one in which plants play the leading part. The value of the domestic and foreign trade in plant products far exceeds that of any other group of commodities.

Political activities and plants.—In addition to the effects of plants on economic, commercial, and historical activities, there are numerous ways in which plants affect the political policies of states and nations. Since the cotton plant is well adapted to the southern environment of the United States and since slavery and cotton growing harmonize, ~~it~~ may be said that the cause of the civil war can be in part attributed to the cotton plant.

The political difference of opinion in regard to *tariff* laws on some plant imports is another illustration of the relation between plants and human desires. In general, the producer of plants similar to those imported, demands a high tariff; while the manufacturer favors a low rate in order to obtain his raw material at the lowest price possible.

Brazil has introduced a " valorization " scheme on all coffee exports in limiting the amount so that the price of coffee will not be lowered by an over-supply on the market. The desire for the world's monopoly of the rubber production by the British and the Dutch is a matter of international significance. Numerous other examples of the influence of plants on political activities are confronting our national as well as international interests, daily.

Effects of man's activities on plants.—Again, since geography is a study of the reciprocal relationship between man and his environment, it is necessary to consider, in the discussion of plant geography, not only the effects of plants on man but also the influence of man's activities on plants. The effects of human agencies on the vegetation of the environment may be expressed in numerous ways. It is seen in the *lumbering* industry which is responsible for the cutting of trees over millions of acres. In the settlement of new lands, vast areas of natural vegetation have been removed to make way for agriculture. Fire, in some cases caused by man's carelessness, has been largely responsible for the disappearance of forest over extensive areas in the western regions of the United States. It has also been responsible for the transformation in many forest regions by eliminating desirable species which later have been replaced by less useful plants. The westward limits of the forests in the prairie region of the United States have been attributed to fire.

Plants have also been given a *wider distribution* over the earth as a result of man's desire to grow the most useful crops.

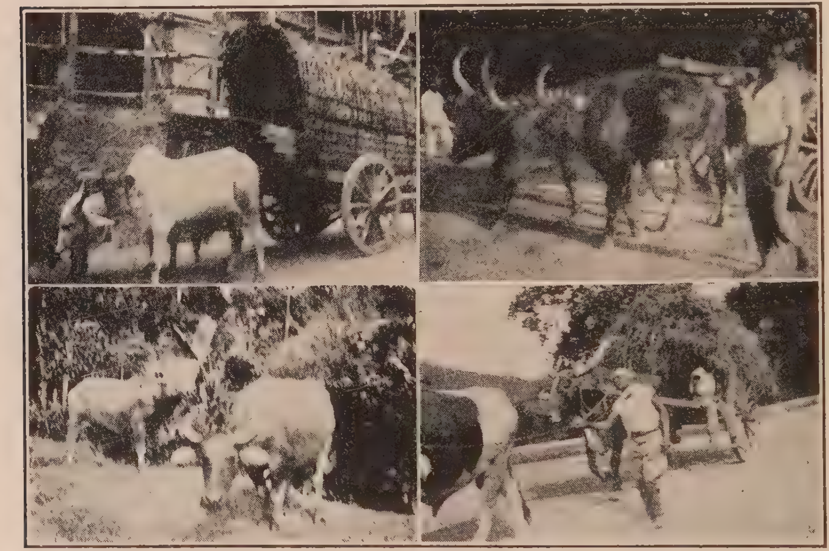
The old world received from the new world, potato, corn, sweet potato, tobacco, and cocoa. The Para rubber plant is a native of Brazil where it served as the only commercial supply of rubber for many years. But in 1866, it was introduced into Ceylon, which was the beginning of the rubber cultivation in the region of the East Indies, our present source of supply. Nearly all of our domestic plants have been improved from time to time by man through the science of plant selection, crossing, and cultivation. Thus, the plant landscape is continually changing, a condition which intrinsically exemplifies the very nature of geography, as a dynamic science in which activity or change is a most fundamental principle.

Animals and Their Geographic Importance.

Animals complex.—Animals are more numerous and varied in their characteristics than plants. Furthermore, in contrast with the constructive processes of plants in changing inorganic substances to organic or living matter, animals are entirely destructive. While regions of similar environment have like animal forms, the number of exceptions is much greater than in the case of plants. The structure of animals ranges from the unicellular protozoa to the largest living mammals, the elephants. Some animals are harmful to man and others are beneficial. In a like manner, man has eliminated some animals and improved others. In this discussion our attention is confined, mainly, to the domestic animals and wild fauna that are useful to mankind.

Animals as burden bearers.—In the capacity of burden bearers, animals have faithfully served man. Although animals for draft purposes have been somewhat replaced by mechanical devices, man is still far from complete independence of animal power. Animals that are suited to their environment are often able to overcome surroundings that are effective barriers to vehicles or machines propelled by power engines. Dogs and reindeer, as draft animals in the far North, have encountered little competition from the automobiles. In the temperate regions, the horse has largely lost his supremacy as the principal and most dependable burden bearer.[1] (Fig. 42.)

Mules are extensively used in the subtropical and tropical areas. In many tropical lands, cattle serve as draft animals. This is particularly true in India, where the work of hauling and plowing is performed by cattle-drawn carts and ploughs. Likewise, in Latin America, cattle are the typical draught animals. (See Figs. 83 and 116.) The lumbering camel supplies the necessary animal power in the tropical deserts. On the slopes of the Andes the llama and the alpaca, animals closely allied to the camel family, are the principal burden bearers.



Photos by C. C. H.

Fig. 116.—Draft Animals.

Upper (Left).—Humped oxen and characteristic cart with thatched cover. Colombo, Ceylon. Note bamboo scaffolding on building under repair in background.

(Right).—Native driving oxen in Lourenco Marques, Portuguese East Africa.

Lower (Left).—Water buffalo used in rice fields of Java. Note dense equatorial vegetation.

(Right).—Driving oxen tandem near Rio de Janeiro, Brazil.

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[1] In 1928 the farms of the United States had about 19 million draft animals, nearly as many as in 1900. During that period, however, the mechanical power, exclusive of automobiles, increased on farms from 5 million to 39.7 million horse power.

Mules are also used as pack animals in mountainous areas. To a limited extent, the elephant is used as a draught animal in India and in its native land, Africa. (See Fig. 117.)

In former years, the efficiency and amount of animal power were a direct measure of prosperity, whether applied to nations or individuals. To-day, the contrary is true. The present tendency is to judge advancement on the basis of mechanical power. This is truly a machine age.

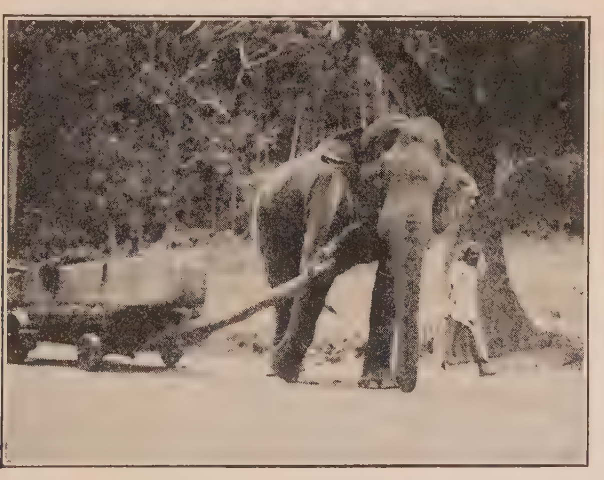

Photo by Drucker, 1927.

Fig. 117.—Elephant drawing log near Kandy, Ceylon. Note vegetation of monsoon area.

Cattle industry.—Cattle are widely distributed throughout the agricultural regions of the world. The ideal environment for cattle is one that favors a luxuriant growth of succulent grass. Hence, the temperate grasslands or prairies and the tropical grasslands or savannas are best suited to the raising of cattle. This is shown in the pampas of Argentina, the prairies of the United States, or the tropical grasslands of Australia. Cattle are also raised extensively in regions having a marine climate. The cool summer and the mild winter are particularly favorable for pastures. Thus in the British Isles and in North Central Europe, where a marine climate prevails, there are many cattle. However, the purpose or utilization of cattle affects their environmental requirements.

The *principal uses of cattle* are for (1) draft, (2) beef, and (3) milk. In India, Africa, China, and Japan, cattle are used primarily for *draft purposes.* The cattle of these countries are as a whole inferior in milk and beef production. The farmers of tropical Latin America are also dependent upon their cattle as draft animals. However, in most countries, cattle are not raised for draft purposes but rather for the production of milk or beef. The principal *dairy and beef cattle* countries are the United States, Great Britain, France, Germany, Central Europe, and Russia. In the mediterranean lands of Europe, Argentina, Australia, and Brazil, beef cattle are more numerous than dairy. The most marked dairy countries are Switzerland, Holland, and Denmark. The rearing of cattle for draft purposes does not require so rich a pasture as that needed for beef or dairy cattle. Beef cattle are generally raised on the prairie grasses and receive very little attention. The dairy cattle, however, require not only daily attention but also need a rich ration. The beef cattle industry may be recognized as an example of extensive agriculture and the dairy industry as intensive.

Before the era of railroads, cattle were raised, primarily, for their *hides.* Some of the beef was consumed as fresh meat or prepared as jerked or salted beef but most of it was considered a waste product. After the development of railroads and refrigeration the situation was reversed; meat became the more valuable product with hides the by-product. The distance in meat shipments was also increased. In the United States, the supply of fresh beef comes from the western prairies while Europe receives beef shipments from Australia, New Zealand, Argentina, and Canada.

Cattle and land utilization.—The beef cattle industry in the United States is competing for land with the wheat and sheep industries. Much of the land formerly used for cattle pastures has been subdivided into small ranches and employed for wheat cultivation. In the forest regions where free grazing land exists, the cattle men and the sheep men are fighting for land rights. Likewise in Argentina, the wheat cultivation is increasing in area and tending in many places to replace the cattle industry. These conditions will eventually necessitate the use of new lands for the raising of beef cattle.

Future cattle-raising lands that are physically suitable to the industry are to be found in the interior states of Brazil, the Llanos of Venezuela, and the Savannas of Africa. In Brazil, the greatest possibilities for the cattle industry lie in the states of Matto Grosso, Goyaz, and Minas Geraes. Here there are literally uncounted millions of acres of virgin land that is ideal for the beef cattle industry. The Llanos of Venezuela are, with the exception of mesas, slight elevations here and there, level grassy plains which await the future cattle ranches. In Africa, the most extensive undeveloped cattle lands are in the countries of Northern Rhodesia, Southern Rhodesia, Angola, and the Sudan.

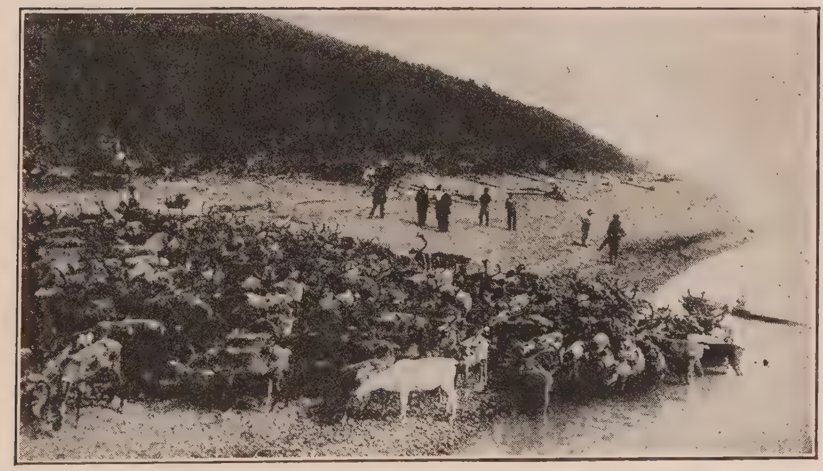

Photo by U. S. Forest Service.

Fig. 118.—Reindeer, mountain village, Alaska. An increasing source of meat supply for the United States.

Dairying.—The dairy industry includes the raising of cows for milk, the manufacturing of butter, cheese, and condensed and powdered milk. Unlike the beef cattle industry, the dairy activities are conducted near centers of population. In America, among the states leading in the production of milk and milk products are Wisconsin, New York, Minnesota, Michigan, Ohio, and Illinois. In Europe, the milk cows are found primarily in the northern countries or in the regions of dense population. In the dairy industry there is a marked degree of specialization. Some regions are known for their marketing of fresh milk while others are associated with the production of butter or cheese. For example, New York State markets most of her dairy products as fresh or condensed milk. Minnesota and Wisconsin specialize in the production of butter and cheese. In international trade, Holland is generally recognized as a producer of butter; Denmark is associated with cheese; and Switzerland has established a reputation in the production of milk and cheese. The geographic factor of location and the social element, called prestige or reputation, contribute to the numerous economic reasons for these specializations in the production of dairy products.

The *demand for dairy products* is constantly increasing. In addition to a greater human consumption of fresh milk, the manufacturer is using a greater quantity of milk, especially for the production of condensed and evaporated milk, and ice cream. In 1922, the total production of ice cream in the United States was 263,500,000 gallons as compared to 324,700,000 gallons in 1926. In the same period of time, the amount of condensed and evaporated milk increased from 1,431,500,000 to 1,733,500,000 pounds. The total amount of milk produced in the United States in 1922 was 102,562,200,000 pounds and 120,766,500,000 pounds in 1926.—One quart of milk weighs about two pounds.

In general, it can be said that dairy products are consumed primarily by people of north European extraction. Races of subtropical or tropical lands use olive oil, cocoanut oil, and other vegetable oils and fats in place of butter, cheese, or milk. However, some butter and cheese are used, but very little milk is consumed. This is due, in part, to the difficulty in keeping milk fresh in regions of high temperature, and inefficient means of refrigeration. In most cases, the milk is boiled before it is used in tropical lands.

The total number of dairy cows in the United States, at the beginning of 1927, was 21,818,000 which was 370,000 less than the previous year and the lowest number since the beginning of 1922. Nevertheless, milk production in 1927 was somewhat above that in 1926. The decrease in number of dairy cattle and the increase in milk production are attributed to the elimination of low-producing cows and the selection and the improvement of pure breed cattle. In general this applies to all dairy countries of the world. The tendency is to decrease the total numbers but increase the quality of the cattle. That is, man is learning to increase production by better utilization of this environmental factor.

Other important domestic animals.—Sheep, goats, and pigs are among man's most useful animals. They provide food for human consumption and raw material for the manufacturing industry. The nature of these products needs no introduction. The raising of *sheep* is carried on primarily in the dry regions of the temperate zones, while goats are reared in the dry areas of the tropical zone. (See Fig. 43.) This is shown in Argentina, Australia, Brazil, and the United States. Both sheep and goats are known as close grazing animals. They are able to get sufficient food from pastures unsuited to cattle. The raising of sheep and goats is often nomadic in character. In many countries, these animals are pastured in mountainous regions during the summer months and returned to the lowlands for their winter corral. (See Fig. 67.)

Pigs are raised in the corn belts where they are fed primarily on corn. By this method the farmer gets a greater financial return for his corn in selling it as pork rather than as grain. Also in densely populated countries such as China, the production of pigs is a sound economic practice. Pigs are scavengers, eating what man does not consume, and therefore not competing with him for food. Furthermore swine multiply with great rapidity. It has been recorded that a sow and her offspring, in twelve months, have produced a total of 2400 pounds of pork. This is one reason why the Chinese have chosen swine as their live stock. The absence of pigs in the thickly populated country of India is due to the religion of the Mohammedans who regard the pig as an unclean animal.

The United States is first in the international trade in pork products and among the leading countries in the buying of wool, skins, and hides. In round figures, the United States consumes 600,000,000 pounds of wool annually, and produces only one-half that amount.

Poultry industry.—Before concluding this brief discussion of the farm animals, the domestic and internal importance of poultry products warrants some mention. Poultry commands the same position in the economy of a farm as that attributed to pigs. They are easily kept, require little space, multiply rapidly, and produce large quantities of food per unit. The international trade in poultry products, particularly eggs and egg products, is of considerable importance. In the United States, eggs in shell constitute the bulk of the poultry products exported, while egg products such as albumen or dried "white" of egg used in bookbinding, leather working, calico-glazing and the like, form the bulk of the imports. Our imports of egg products, coming mainly from China, amounted to $5,100,000 in 1927. Cuba is our largest market for eggs.

Fishing industry.—The most important centers of the fishing industry are on (1) the North Atlantic coast of Labrador, Newfoundland, Canada, and the New England States; (2) the North Pacific Coast of Oregon, Washington, British Columbia, and Alaska; (3) the coasts of North Western Europe, including the North Sea; and (4) the coast of Japan. Also, large quantities of fish are caught in our rivers and lakes. This apparent localization of the fishing industry is largely a matter of environment.

Nearly all fish seek shallow water during the spawning period. They lay their eggs in rivers or in the shallow water over the continental shelf. Fish also collect in shallow water where there is an abundance of food in the form of minute plants and animals. These conditions are fulfilled in the great fishing regions of the world.

The *North Atlantic region,* and particularly the Newfoundland banks have attracted European and American fishermen for centuries. Long before colonies had been established in North America, fishing vessels sailed back and forth from Europe to Newfoundland. The interest of the French in the

St. Lawrence valley can be attributed in part to the nearness of the great fishing banks of Newfoundland. The present occupation of Labrador by the British, centers entirely around the fishing industry. Gloucester, Mass., and, later, Boston developed into the leading fish ports of the United States because of their proximity to the Newfoundland banks.

The principal fish caught in the North Atlantic region are cod, haddock, mackerel, and herring. Lobsters are trapped in great numbers along the New England coast. The oyster, the most valuable fish product in the United States, is found along the Atlantic Coast from Cape Cod to Galveston but the most important districts are the Chesapeake Bay and Long Island Sound. Baltimore is the center of the oyster canning industry. From Baltimore, canned oysters and fresh oysters are shipped to the interior cities of the United States and foreign countries.

The *North Pacific Coast region* is the center of the salmon fishing. From the rivers of Alaska, British Columbia and northwestern United States, the salmon is caught in such tremendous quantities that there is a fear of possible exhaustion of this important fish. The total production of canned salmon for Alaska, Washington, Oregon, and California in the year 1927 was about 244,000,000 pounds, valued at approximately $46,000,000. In this same region are caught cod, halibut and herring.

The *northwestern Europe region* reaches from Lapland to Morocco. It also includes the coasts of Iceland. The North Sea and the waters of the shores of Iceland are the principal fishing areas of this region. It has been reported that the British fisheries support about a million of the population.[2] The Norwegians are likewise busily engaged in fishing. In Iceland, the fishing industry has always been one of the chief occupations. In 1923, the export of herring amounted to 19,000 tons, the total export of fish to 59,464 tons. The greater part of the fish are exported salted, or salted and dried. As a whole, the principal fish caught in this region are herring, cod, and haddock.

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[2] Stamp, "*An Intermediate Commercial Geography.*"

The *fourth fishing region,* the coasts of Japan, is of greater value on the basis of human necessity than any of the other major fishing centers. The number of people dependent upon fish for food is greater in Japan than any European or North American country. Herring, haddock, and sardines are the principal fish products of this region.

Other fishing regions of commercial importance are (1) Western Mediterranean, (2) New Zealand and Southeastern Australia, (3) Cape of Good Hope, and (4) the Great Lakes of North America.

In addition to food, there are many other commercial products derived from marine animals, including such as furs, leather, oils, sponges, shells, glue, and fertilizers. These products as well as fish are included under the general heading of fisheries.

The fur industry.—With the same degree of geographic importance with which the fishermen have charted the seas, the fur hunter or trapper has explored the lands. At an early stage, man journeyed far from centers of human habitation into the interiors of continents in search of fur-bearing animals. He acquired a knowledge of mountain passes, river valleys, and forest trails which has proved valuable for the pioneers and travellers of later years. The activities of the trapper led to the establishment of fur-trading posts, which in many cases developed into permanent towns and cities. St. Louis, Mo., is an illustration of a city that owes its location to a fur-trading post, and one that has also increased its importance in becoming the greatest fur market of the world.

While *fur-bearing animals* are caught in nearly all humid lands, the greater percentage of the supply comes from Alaska, Canada, Russia, China, and the extreme southern part of South America. Within these regions are extensive areas which provide no other income than that obtained from the fur trade. The Pribilof Islands in the Bering Sea, the greatest center of fur seal fishing in the world, disclose the importance added to a region by animal life. Among the other commercial fur-bearing animals caught throughout the world are fox, muskrat, mink, skunk, martin, beaver, otter and sable.

Owing to the increasing scarcity in fur-bearing animals and a greater demand for fur products, there has been, in recent years, a marked development in *fur farming* in the United States. It has been reported that fox farming is well established throughout the northern part, and that practically all of the silver and black fox used by the American furriers are raised on farms. Muskrat farming is also widely practiced. Mink, martin and rabbits are also being raised domestically.

Although the United States is the largest producer of raw furs in the world, the total value of fur imports in 1927 amounted to only $135,574,000. China was the largest supplier of furs with a valuation of $27,455,000, followed by the United Kingdom with $22,196,000, Canada with $15,066,000, Germany with $14,338,000 and Australia fifth, with a shipment valued at $10,972,000.

CHAPTER XVI

SOCIAL FACTORS IN ENVIRONMENT

Man as an Environmental Factor.

Distribution of population.—In Chapter II attention was called to the different densities of population in different parts of the earth, and to the fact that the standards of living vary among people of different places. Other chapters have brought out the point that various *environmental factors*, such as climate, land forms, soil, water, minerals, plants and animals,

HOW MANY PEOPLE MAKE A STORE?

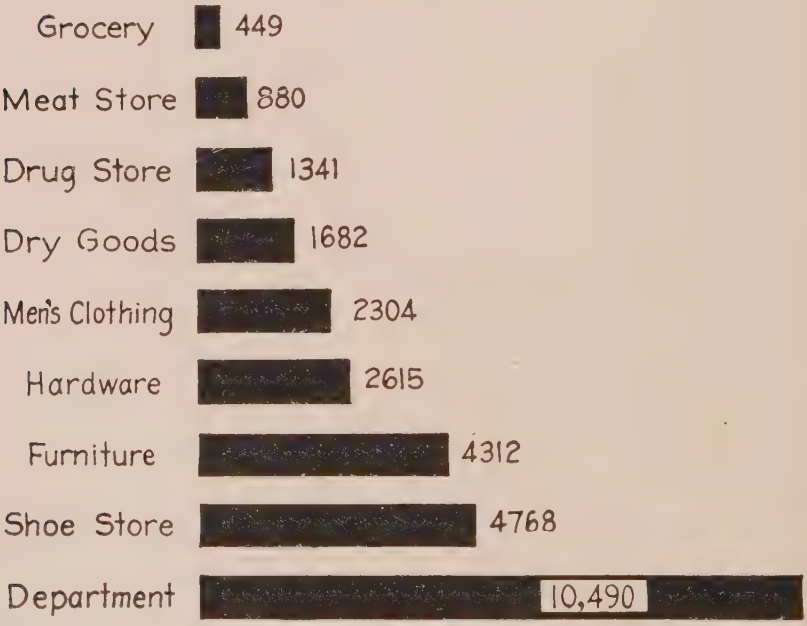

Fig. 119.—The Average Number of People Required to Support a Store in the United States. (According to survey made by the United States Chamber of Commerce.)

have very *important influences upon where people live* and why they thrive more in some places than in others.

Perhaps enough has been said to suggest the fundamental fact that the most of the earth's surface supports nearly, if not quite, as many people as it can under the existing methods of production, and with *the prevailing standards of living.* Even a new country like the United States with its abundant resources can not go on increasing its population at the rate it has in the past without new and better methods of getting food, energy, and raw materials, unless it lowers its standard of living. In fact, our rate of population increase is already slowing down, and we are continually profiting by the advancements of science in methods of production and utilization, yet there is a strong indication that thousands of the poor in our congested cities tend to adopt a lower standard of living than similar groups a generation or two ago. Nor is this tendency altogether lacking among the farmers and miners. For example, the use of less meat, or of cheaper kinds of meat in the diet, has been due, in part, to the fact that our domestic animals have not been increasing so fast as our population.

Merely as an environmental factor, in the surroundings of any group of people, the existence of constantly increasing numbers of other people influences the lives of the group in many ways, some helpful, some not. Thus, if you are running a retail store, the size of the population about you is important, for population is a big factor in retailing. The business of a retail store depends upon the potential number of people it serves, and fluctuations in that number may be the chief factor in determining its failure or success. (See Fig. 119.) Now-a-days with modern developments in transportation and communication *our environment is world-wide,* so that not only our neighbors but any of the peoples or races of the globe are likely to exert a geographical influence upon us and our activities. Take the ocean-going foreign trade of the world, for example. Note how it flows between the regions of dense population. (See Fig. 120.)

The races of the world.—The population of the globe has been divided into *three primary racial types:* the white, the

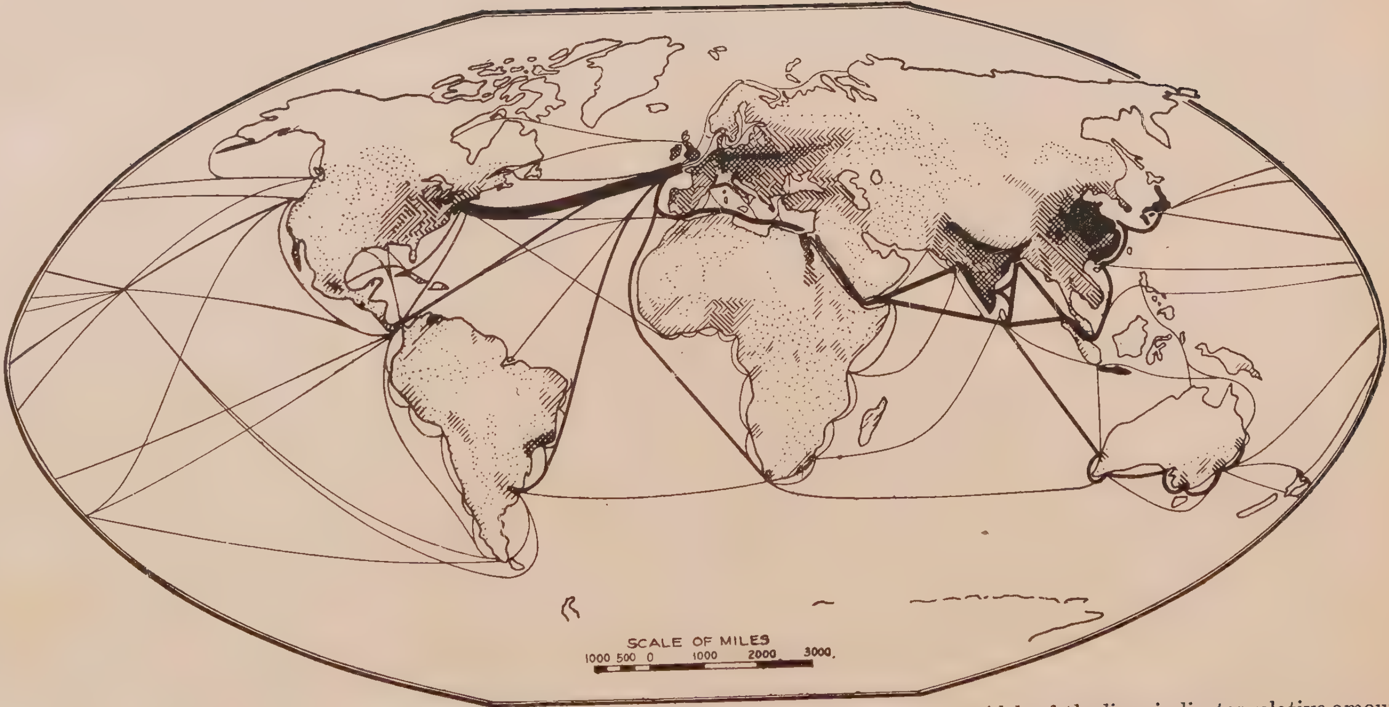

Fig. 120.—The flow of over-seas commerce between regions of densest population. The width of the lines indicates relative amount of trade. (For key to population see Fig. 1.)

black, and the yellow.[1] These three types include nine-tenths of all the nations and tribes of the earth, and 99 per cent of the individuals. Amidst the various migrations and intermarriages of peoples, some groups have emerged with characteristics that indicate they should be considered probably as *blends* of two of the main types or transitional stocks. Thus, the Ainus of Japan and the Polynesians of the South Sea Islands partake of the characteristics of both the white and the yellow types. (See Fig. 45.) The Maoris of New Zealand seem to be of Polynesian stock. Then there are the

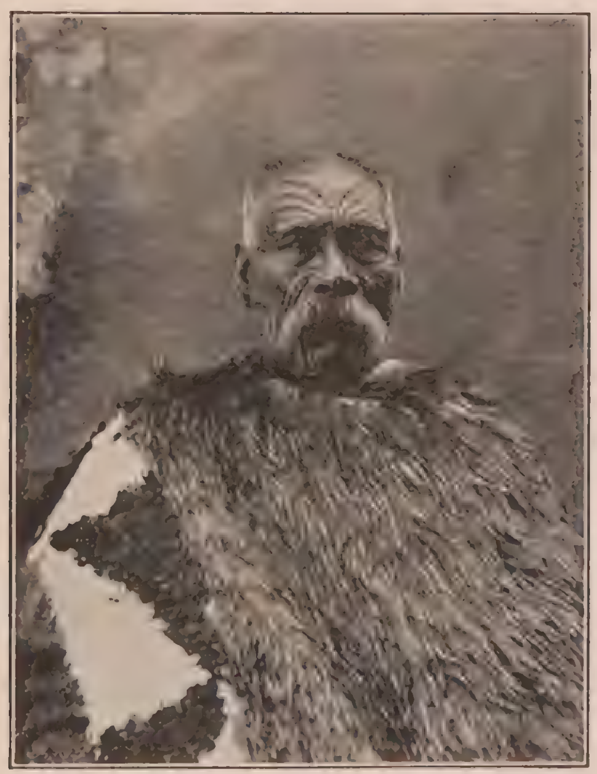

Photo by courtesy of Tourist Dept., New Zealand Government.

Fig. 121.—A Maori Chief in Native Costume of Feather Construction. Rotorua, New Zealand.

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[1] Chap. II. These are sometimes called the Caucasian, the Negroid and the Mongoloid. See p. 26.

native Australians, black and long-headed like the negroes, but with hair characteristics of the whites. (See Fig. 122.) The Indo-Australians of southern India, Indo-China, and the East Indies, seem related both to the Australians and to the whites. Physically short, slight, broad-nosed, and long-headed, but with fine wavy hair, they are still uncivilized and seem likely to become extinct.

Photo by C. C. H.

Fig. 122.—Australian boy with boomerang. A descendant of the aborigines of New South Wales.

The three primary types are divided into races. Thus the Caucasian or *white type* includes four races: the three races of Western Europe, discussed in Chapter II; and the *Hindu,* which has its main habitat in northern and western India. Its traces are found all over India, but in the east and south it blends into other races. (See Fig. 123.) The northern Hindu is the purest of the stock. These four white races are sometimes spoken of as Indo European, the Nordics, Alpines, and Mediterraneans being confined chiefly to Europe. The Mediterranean race once occupied all shores of the Mediterranean Sea; but it has been crowded out of the Balkans and Asia

Minor, and in Arabia and Northern Africa it has been so modified by intermixture with other races that in some places it is hard to recognize.

The yellow or *Mongoloid type* may be classified in three distinct races: (1) The Mongol proper, with broad head and face, light or yellowish-brown skin, slant eyes, and slightly below medium stature; (See Fig. 124.) (2) the *Malay* or Malaysian, slightly shorter than the Mongols and with less slant appearance of the eyes, but with a broader nose and a brown color; (3) the *American Indian,* similar to the Mongol, but broader of face, taller in stature, and of a reddish or copper-brown color.

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Fig. 123.—Types and Scenes in India.
Left.—A gentleman from Colombo, Ceylon.
Right.—Scene in narrow streets of Amritsar, Punjab (India).

The Mongol proper is found in general throughout Asia, except in the southern and southwestern parts, where the Hindu and Arab and other related peoples dwell. The Chinese, Japanese, and Koreans are typical of this race, but the farther it extends south, southwest, or west the more it becomes mixed with other races and types. In Europe the Cossacks of Russia, the Magyars of Hungary, the Lapps, and the Finns are of Mongolian blend. The Malays occupy the

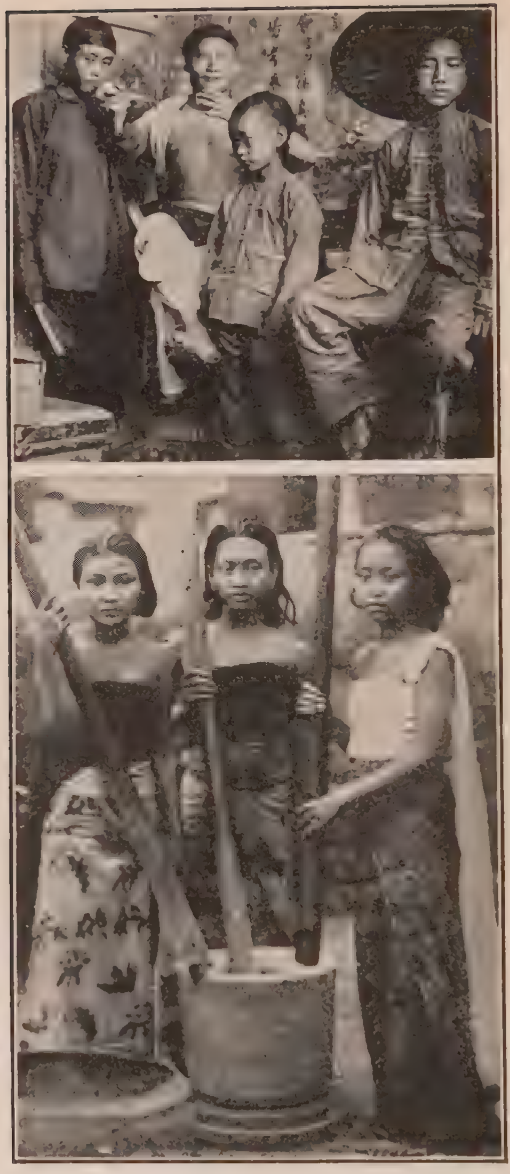


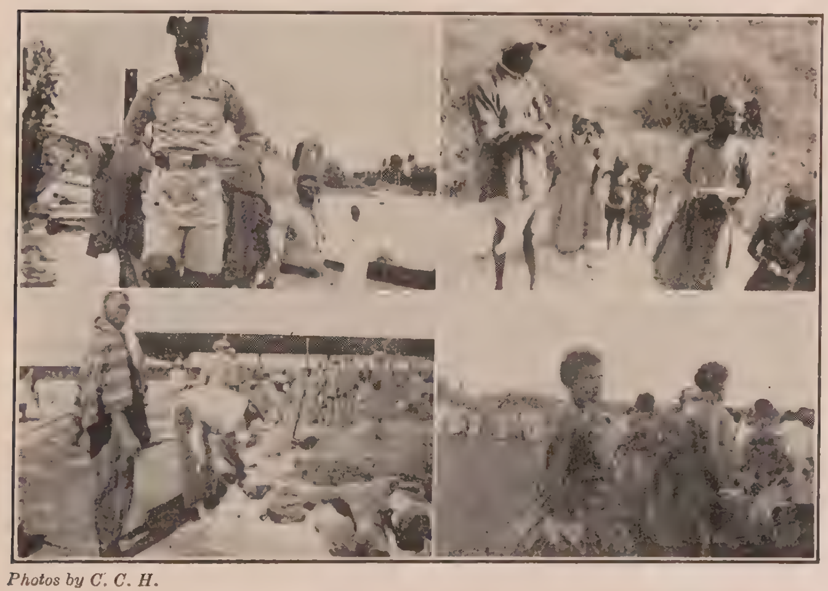
Fig. 124.—Racial Similarities. Yellow Type.

Upper.—A typical scene in a Yunnan-fu shop, China. (Photo by courtesy of Publicity Bureau, U. S. Dept. of Commerce.)

Lower. Three Javanese maidens cleaning rice. Note their Batik costumes. (From a photo purchased in Batavia.)

See also Fig. 136.

islands of the East Indies from Sumatra around the South China Sea to Formosa and southeastward almost to New Guinea. The American Indians are the natives of both North and South America, and are most closely connected to the Mongols through the Eskimos who are separated from the Asiatic mainland only by the narrow Bering Strait. (See Fig. 136.)



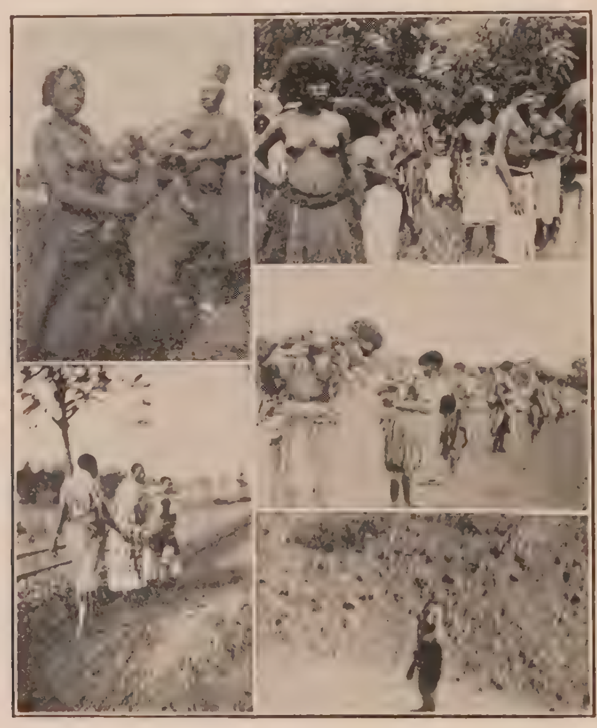
Photos by C. C. H.

Fig. 125.—Black Types.

Upper (Left).—Negro policeman at Dar-es-Salaam, East Africa.
(Right).—Natives of Bechuanaland, edge of Kalahari Desert.
Lower (Left).—Native workers in compound of gold mine, South Africa.
(Right).—Native women in fan dance, Suva, Fiji Islands.

The black or *Negroid* type also includes three races: (1) The *African negro,* tall, long-headed, broad and flat-nosed, brown or black-skinned, and with short, black, coarse woolly-hair, inhabits Africa south of the Sahara, also the western half of Madagascar. The Negro race includes Bantus and Sudanese, also the Hamites and the Nilotics farther north where they have mixed more or less with Arabs. (2) The *Negritos,* fewer in numbers, are scattered from the Kalahari desert in South Africa and the equatorial forests of central Africa eastward to the East Indies. They resemble the other

Negroids except that all these but the Bushman of the Kalahari are broad-headed. They are also smaller in stature, the men averaging less than five feet. In fact they are often called Pygmies. Timid and inoffensive, they have been crowded back till they now occupy chiefly deserts, jungles, and other undesirable places. (See Fig. 125.) (3) The *Melanesian* race inhabits the islands between Malaysia and Australia and extending from New Guinea to Fiji. Those in New Guinea speak the Papuan language, the rest Melanesian. This race very closely resembles the negro though separated from them



Photos by C. C. H.

Fig. 126.—Racial Similarities. Black Type.

Upper (Left). Zulu matrons, Natal, South Africa. (Right).—Natives of New Guinea arrayed for dance.

Middle.—Natives of Fiji Islands in their celebrated fan dance. Compare the first man's side view with the one in the picture above.

Lower (Left). Three ladies of Northern Rhodesia. Contrast these tall natives of the good grass lands with the queer-looking little native of the Kalahari Desert (Right) by five or six thousand miles of the Indian Ocean. However they are not quite so tall and the broad nose is arched instead of flat as in the case of the negro. (See Fig. 126.)

Influences of races in the world environment.—These various races differ as much in language, culture, and economic advancement as they do physically. Lack of knowledge and real understanding of one another has often resulted in jealousy, hostility, and war, even among those races most advanced. The presence of so many backward and often restless races in the British Empire presents many serious problems to the Commonwealth, which is therefore now beginning a program of careful regional planning.

The proximity of a more powerful race may threaten the liberty or even the existence of the weaker one, so the latter may be forced to provide defenses, to fight, to pay tribute, or to migrate to a less desirable or more inaccessible habitat to avoid enslavement or extinction. Thus we find the Bushmen in the hot Kalahari, the Basques in the Pyrenees, the Irish in Ireland, and the most of our own American Indians in the far west, each having been pushed back by the expansion of a more powerful race.

The existence in our world environment of so many races with lower standards of living, culture, and religion has provided the basis for many great relief funds and expeditions, as well as vast missionary organizations and activities.

Differences in races and in social development as factors in trade.—That these various races have widely different wants provides a basis for foreign trade. Differences in industrial development constitute a fundamental reason for commerce between races. If one is in the agricultural stage, it is willing to exchange its surplus of foodstuffs and raw materials for the manufactured goods of peoples more advanced industrially. What is called "frontier trade," with a race low in culture, often proves very profitable to the more advanced race; because for articles of small cost it can usually get in exchange many things of great value, as the furs the whites in colonial days got from the American Indians, or the ivory the modern white traders get from the African negroes. Even between races of comparatively equal standing, racial differences constitute a fundamental factor giving rise to trade. As knowledge of one another grows and racial prejudices break down, however, industrial imitation tends to develop and racial differences, as conducive to trade, tend to balance up and disappear.

Man-made Environment.

The works of man.—On the topographic maps of the United States Geological Survey such things as houses, roads, canals, railways, forts, mines, docks, dams and cities are marked as cultural features of the landscape. They are, nevertheless, part of the landscape and as such are important elements of the environment, of the physical environment if one prefers this expression. Now all these works of man influence, in one way or another, the distribution and activities of man, and man utilizes each of them in various ways; hence many relations between them and human affairs are geographic.

Canals.—Some mention of canals was made in the chapter on the utilization of water. As a means of transportation they supplement and connect natural bodies of water, as rivers or oceans. As such they often stimulate trade between regions; lower freight rates by providing alternative transportation routes to shippers; and save shippers time and money by shortening the distance for shipping. Thus, the opening of the Suez canal connecting the Red Sea with the Mediterranean saved British vessels on the way to India the necessity of going clear around Africa by the Cape of Good Hope route, involving also two crossings of the hot equatorial region. Something of the extent to which the Suez canal is utilized is indicated by the fact that during the year 1927, the number of transits of commercial vessels through the canal was 5545, and the total weight of their cargoes was 29,524,000 long tons. Three thousand and eighty-five of these vessels flew the flag of Great Britain, but the others included vessels of Holland, Germany, France, Italy, Japan, Norway, United States, and others.

The Panama canal.—The Panama canal connecting the Atlantic and Pacific oceans had almost as many commercial vessels as the Suez canal, go through it in 1927, the number being 5475, of which 2685 were United States vessels, 1351 British, 265 Norwegian, 212 German, 165 Japanese, 116 French, 106 Swedish, and 105 Dutch. There were also Chilean, Danish, Peruvian, Spanish, Italian and other vessels; the total tonnage of cargo being 20,697,000 long tons.[2]

The *construction* of the Panama Canal was one of the world's greatest engineering feats. Work was begun on it by the French in 1882 and they spent millions without much progress. Their rights and property were purchased by the United States Government under Act of Congress, June 28, 1902. American occupation of the Canal Zone began May 4, 1904, and in 1914 the canal was opened. The expenditure on it by the United States up to that time was approximately $375,000,000.

The line of *this canal follows the valley* of the Chagres River on the Atlantic slope, passes through the Continental Divide in the Gaillard (Culebra) Cut where the elevation was originally 312 feet above sea level, and descends to the Pacific down the valley of the Rio Grande. The length of the canal is 42 miles between the shore lines, and 50 miles from deep water in the Atlantic to deep water in the Pacific. By building a dam across the valley of the Chagres River, the world's largest artificially formed lake (Gatun Lake) was made to serve for part of the canal. Its level, 85 feet above the Atlantic, is reached by the three steps of the great Gatun Locks 1⅕ miles long, including the approach. (See Fig. 127.) Thus the depth of the cut, 300 feet wide at the bottom of the channel, through the Continental Divide was reduced by 85 ft.; but this cut is 8 miles long to the first lock on the Pacific slope, and from it were excavated 100,000,000 cubic yards of material. (See Fig. 127.) The descent to the Pacific is made by two sets of locks, Pedro Miguel ⅚ of a mile long, and Miraflores slightly over a mile. The latter has extra depth on account of the tidal variations of the Pacific, which are as much as 12½ feet.

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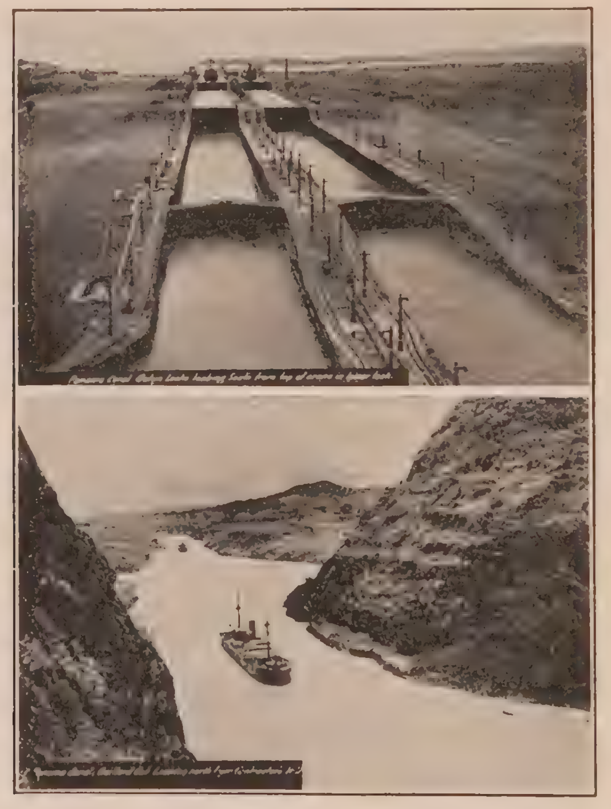
[2] *U. S. Commerce Year Book,* Vol. II, 1928, pp. 719–721.

The Pacific end of the canal is about 27 miles east of the Atlantic end. (Fig. 128.)

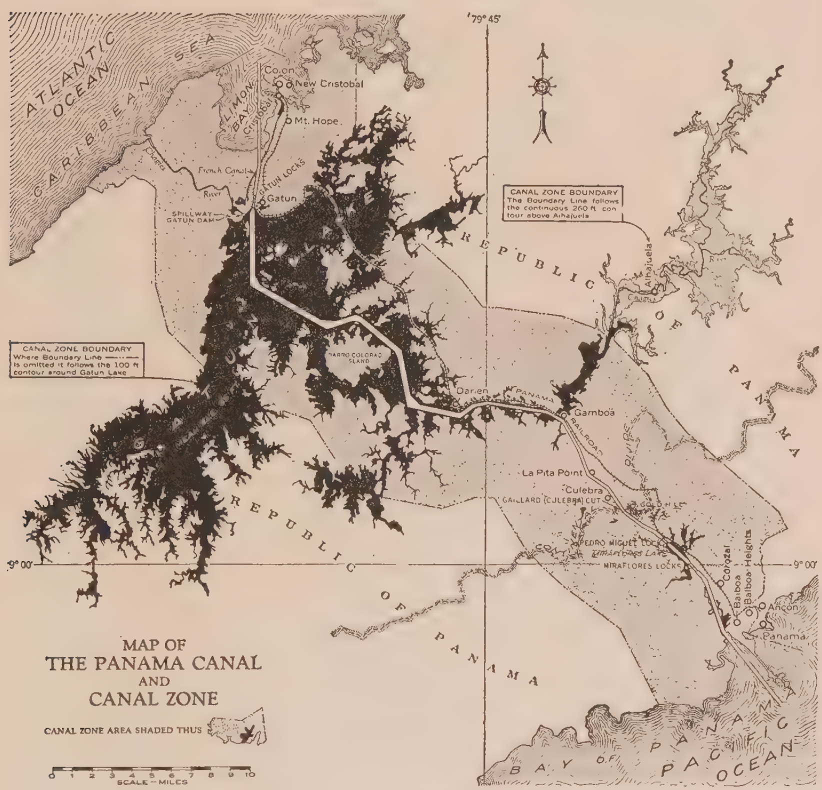
The canal is capable of handling the largest ships, and has a *capacity* of about 48 usual-sized ships a day, or 17,000 a year. Between New York and San Francisco, the distance saved by the Panama canal is 7873 miles over the route by the Strait of Magellan. The Gatun Dam provides by a hydroelectric station an electric capacity up to 22,140 Kilowatt, which supplies electricity to the various towns for the operation of locks, shops, water-pumping stations, coaling stations, refrigerating plants, and for various other industrial and gen-



Photos by courtesy of Pan American Union.

Fig. 127. Two Views of Panama Canal (looking towards Gatun Lake).
Upper.—Gatun Locks.
Lower.—Gaillard (Culebra) Cut.

eral uses on the Canal Zone. Both entrances to the canal are protected by breakwaters. A systematic arrangement of lights and buoys makes the canal safe to use night and day. The completed canal is equipped to offer many facilities for shipping, such as coaling plants, oil tanks, supplies of pure filtered water, dry docks, foundries, repair shops, and salvage equipment.



Courtesy of Samuel N. Wyer.

Fig. 128.

In 1927, over 29 million cargo tons of traffic moved through the Panama canal. Of this, 71 per cent passed from the Pacific to the Atlantic. Eastbound traffic has been much heavier than the westward, largely on account of heavy shipments of crude oil and lumber chiefly to the eastern United States, and grain going to Europe.

This great oceanic canal is not only of vital importance to shipping, particularly to that of the United States, but it plays an *important part in our political and naval strategy.* The opening of the canal and the advance of the United States into the Caribbean region were followed by new policies in what has been called the larger Canal Zone—the West Indies, Mexico, Central America, Colombia, and Venezuela—such as the establishing of protectorates, supervision of finances, control of all possible canal routes, acquisition of naval bases and coaling stations, and the policing of disorderly countries.

Other American canals.—Aside from the Panama Canal, the construction of the *Erie Canal,* connecting the Hudson River with Lake Erie in 1825, was perhaps the climax of the canal building of the United States. It contributed a great deal toward making New York City the commercial metropolis of the country. Down to 1866 its traffic totaled about 60% of the freight moved across New York state. After that its business declined as that of the railroads increased.

The greatest amount of *canal mileage* of the United States at any one time was 4468 miles, built mostly by state governments at a cost of $214,000,000. Nearly all of those canals were financial failures, as they were built about the time of the great financial panic of 1837; and the development of the railroads about the middle of that century caused the abandonment of many of the canals. The *indirect benefits* of those canals to the regions they served were often very great, in that the transportation provided gave a stimulus to settlement, production, development and trade. Some other countries, however, notably Germany and France, have kept their canals up to date and find them still a valuable part of their transportation systems.

Railroads.—As the canal-constructing period followed an earlier turnpike period, so it gave way in turn to the railway, which represented another improvement in transportation. And transportation is not merely important in itself, but it is *a dominating factor* influencing every man's private business, and giving shape to the public policy of every civilized nation. The concentration of industry in large cities is directly connected with transportation. Cities were limited in size by the unavailability of food, when they were dependent upon roads chiefly. But when railroads came, permitting prompt supplies of milk, fruit, and vegetables from a distance, and cheap rates on long hauls of wheat and meat, city growth was greatly increased.

Political and military factors have had a lot to do with railroad extension. Such prompted the building of our first transcontinental railway, the Union Pacific, continued west to California by the Central Pacific. The trans-Siberian railway and the large mountain railroads of the Old World owe their building to the same reasons. The lack of a few miles of railroad is said to have been the probable cause of Austria's losing the battles of Solferino and Magenta in 1859, thus changing the destiny of Italy. Germany's energetic use of every railroad in 1870 permitted her quickly to place her troops in position to strike the blows that practically decided in the first few days the Franco-Prussian War. In the recent Great War, Germany's prompt use of her many strategically located railways enabled her great army to be in Belgium almost at once, smashing its way dangerously close to Paris. Part of the world's railroads are shown on the world map, Fig. 129.

American railway development.—In the United States the Baltimore and Ohio was the pioneer railroad; it was opened early in 1830. There were but 23 miles in use that year but during the next 10 years the American mileage reached 2,818, the roads chiefly radiating from several Atlantic seaports. Philadelphia was the most important center in 1840. By 1850 the total mileage was 9021 miles. Then began the rapid joining up of many short connecting roads into long lines under single ownership. During that decade many of the trunk lines of the large railway systems of the present day were completed. By 1853 one could travel from the Atlantic coast to Chicago by rail. Railway construction in Illinois and beyond the Mississippi River was hastened by land grants, a

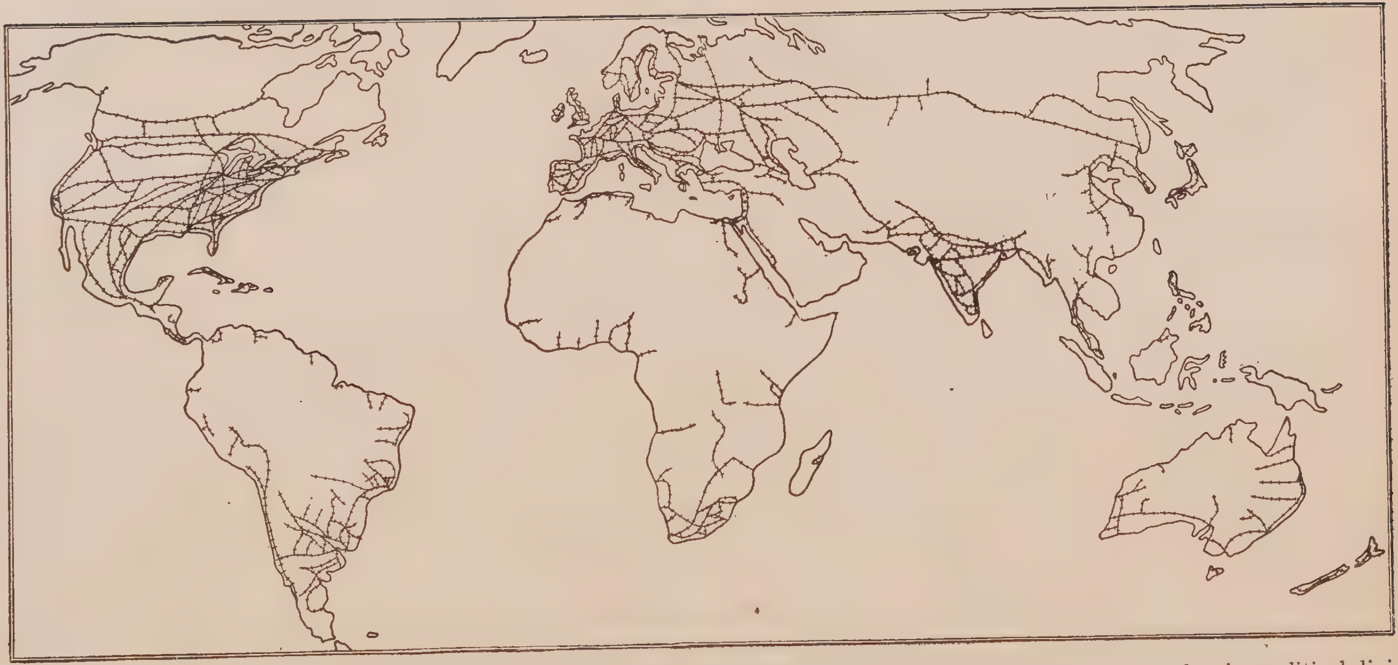


Fig. 129.—The general distribution of the railroads of the world. This map should be compared with that showing political divisions (Fig. 9). Note the tendency of the lines to form a network, here dense and there loose; also the convergence upon certain cities, as Paris and Chicago, forming what French geographers call the spider's web effect.

policy followed by the United States for almost 30 years. The mileage at each succeeding decade is shown in the following tables:

RAILWAY MILEAGE OF THE UNITED STATES

Year	Mileage	Year	Mileage
1860	30,626 miles	1900	198,964 miles
1870	52,922	1910	249,992
1880	93,267	1920	252,845
1890	167,191	1926	249,138

In the 10 years between 1880 and 1890, over 70,000 miles were added, an achievement unequaled in the history of any other country. The three leading countries in Europe had not constructed more than that in 50 years. All sections of the United States shared in this rapid increase at that time, but the central and western states got most of it, as settlement and progress were active there. Often the railways preceded settlement, thus preparing the way for settlers and stimulating development. Since 1890 the building has been less rapid, but at the end of 1925 the mileage of the United States was 249,138 nearly a third of the world's estimated total of 764,238 miles. (See Fig. 130.) Our nearest com-

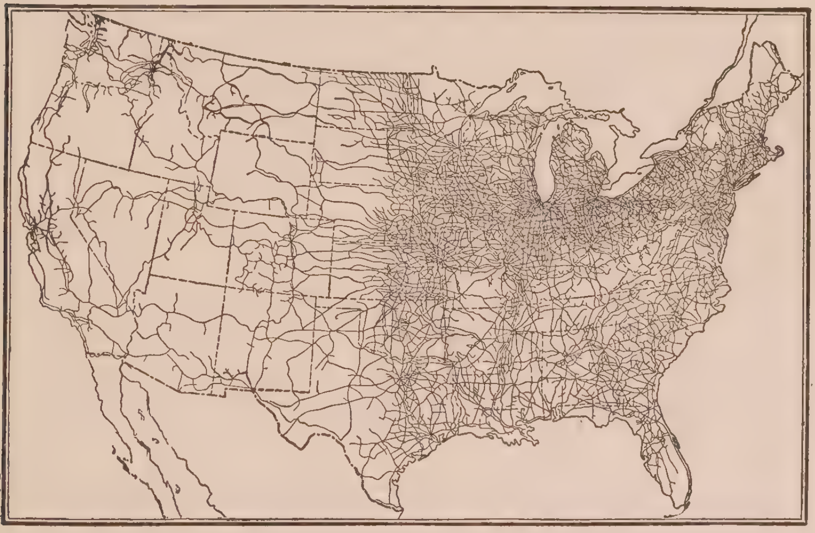


Fig. 130.—The Railroads of the United States.
Compare with Figs. 75 and 113.

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16
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petitors were Russia with 46,350 miles, Canada with 40,352, France 39,475, British India 38,579, Germany 33,231, Australia 26,351, Argentina 23,756, and the United Kingdom with 21,161 miles.[3]

Yet during the Great War our railroads proved unequal to the task of handling the traffic. They seem not sufficiently developed in advance of other industries to take care of the rapid increases in traffic in time of war or of industrial prosperity. Part of the difficulty lies in inadequate terminal facilities. Many of our ports are not properly equipped. This is particularly true of New York. Thus, goods come by rail to the Jersey shore, are taken over the Hudson on car floats, and then delivered to railroad piers on Manhattan Island or Brooklyn, from which food stuffs, for example, are carted to all parts of the city. The distance is often so great that the truck is almost all day making one trip. The congestion is such that trucks often have to wait hours or days to get into the piers. The delays are costly and wasteful, as New York uses over 1000 cars of fruit and vegetables per week.

Bridges.—In the spring of 1929, the War Department was considering an application from the B. & O. Railway, the North River Bridge Co., and others, to build a $180,000,000 bridge across the Hudson, with a lower deck to contain 12 railway tracks and an upper deck to accommodate 20 lanes for different kinds of vehicle traffic and a 15-foot pedestrian promenade on either side. All the railways that now have to discharge their passengers on the Jersey shore, would then be let right into New York City. The Pennsylvania R. R. crosses into the heart of New York by means of an immense tunnel under the Hudson. This is an environmental factor of vast importance. So is the new Hudson vehicular tunnel.

Bridges are among the most common and most important features of the man-made environment. Their importance in aiding man to overcome natural barriers like rivers and ravines is apparent to all. Suggestion of their importance is often seen in the names of cities originally started at river crossings; as, Bridgeport or Cambridge. London Bridge at the first point above the mouth of the Thames where it could easily be crossed, is one of the famous bridges of the world. The utilization of this crossing was an important factor in the location of London.

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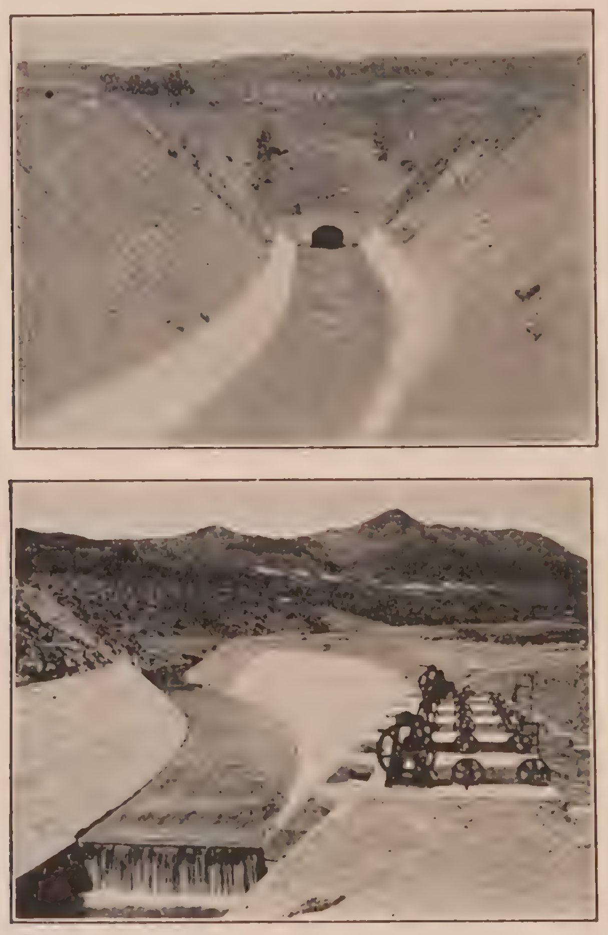
[3] *Commerce Year Book,* 1928, Vol. II, pp. 717, 718.

Great rivers like the Rhine, the Hudson, and the Mississippi facilitate travel up and down their courses, but are serious barriers to crosswise traffic. So bridges become important for the movement both of passenger and of freight. Thirty-eight bridges spanned the Rhine in 1928, eight of them being in Holland. For 500 miles from the mouth of the Mississippi there is no bridge until Memphis, Tenn., is reached. Thus, in all the lower stretches of the river the expense, trouble, loss of time, and sometimes loss of lives, resulting from the use of ferries, bear testimony to the geographic importance of bridges.

Subways.—Subways are particularly important for passenger traffic in large cities, like New York and London, where great concentration of population has caused much congestion of streets along with skyrocketing of land values. The line of the first subway down through Manhattan (New York City) is marked on the surface by a backbone of skyscrapers, bearing witness to the business importance of proximity to this transportation factor.

Tunnels.—Tunnels are of great value to railway transportation in lessening the elevation to overcome in crossing mountains, as the Simplon and St. Gothard tunnels through the Alps from Italy to Switzerland; or in shortening the route in mountainous regions by cutting through instead of going around ridges. The longest tunnel in this country was opened by the Great Northern Railway early in 1929. It is 8 miles long and cost $14,000,000, being cut through the Cascade Mountains to save time in transportation between Tacoma and Spokane, and eventually between Seattle and Chicago. It enters the Cascades at a height of 2881 feet, 500 feet lower than the old tunnel and route over the summit. It saves grades and the extra power to overcome them, and saves money in maintenance costs by eliminating some six miles of snowsheds necessary in the higher altitudes of the route formerly followed. It also eliminates 46 curves and 6 complete circles in a distance of 72 miles, reduces the time of passenger trains one hour in crossing the mountains, and saves freight



Photos by courtesy of U. S. Dept. of Interior, Reclamation Service.

Fig. 131. A Tunnel through Mountain; Water Used for Irrigation.

Upper.—Outlet of Gunnison Tunnel, and South Canal, Uncompahgre project, Colorado.

Lower.—Newlands project, Nevada. View showing the main Truckee Canal with drop at the Durby waste-way, also the top of the waste-way gates.

trains three hours. Moreover it assures the public the increased dependability afforded by all-year operation. Electrically operated trains remove the smoke nuisance.

Previous to the opening of the New Cascade tunnel, the longer tunnels in America were in the Moffatt in Colorado, length 6.11 miles, the Connaught, Rogers Pass, B. C., 5.02 miles, Hoosac, Mass., 4.38 miles, and Mount Royal, Montreal, 3.09 miles. In Europe, the Simplon Tunnel is 12.4 miles long, St. Gothard 9.26 miles, Loetschberg, from Switzerland to Italy 9 miles, and Mt. Cenis, France to Italy 7.97 miles.

Tunnels are also used to convey water supplies to cities, as the tunnel carrying water for New York under the Hudson River from the great reservoir in the Catskill Mountains. A tunnel estimated to cost $100,000,000 is now under way (1929) to take care of the water problem of Boston, it is hoped, for a hundred years to come. This tunnel is to be 11 feet wide, 13 feet high, and 13 miles long, and is being blasted through solid rock at depths of from 200 to 650 feet underground. It is to add to the water supply of Boston, Worcester, and the Metropolitan district by taking the overflow from the Ware River after 85,000,000 gallons have passed daily. New York City, again desiring to add to her already great water supply, is now applying for permission to reach out across New Jersey and tap the waters of the Delaware River, but opposition is being encountered from Philadelphia, Trenton, and other Pennsylvania and New Jersey cities and towns that are thinking of supplies for their own future populations.

Highways.—The revival of the " good roads " movement in recent years is bringing back to life many of the old inns and taverns that were social features in the turnpike era and stagecoach days of the 19th century. Some of this is, of course, due to the advent of the automobile. On the other hand, the construction of good roads has contributed greatly to the development of the automobile industry. Here, as in many other geographic relations, cause and effect have interacted. Within the last 15 years, a fine system of excellent highways has been developed in the United States by local, state, and federal activity, the total mileage now being more than half a million miles of surfaced road. The miles surfaced increased from 153,000 in 1904 to 521,000 in 1926. Other countries notably in Europe, South America, South Africa, and

Australia are also rapidly improving their highways. The fine roads radiating from Paris are credited with having helped save that city from the Germans in the early days of the Great War, when an army was rushed from Paris to the Marne in a few hours.

The extension of suburbs and the touring of motorists are both influenced by the nature of the country's highways. Other effects are seen in the interurban operation of moving vans, trucks, and buses. Wholesalers, mail-order houses, and department stores now often deliver by truck to places on the margin of a wide trade territory. It is estimated that now approximately 40,000,000 people spend at least part of their vacations in motor travel. As this enables better observation and comparison of different places, people, and customs, it is not incorrect to say that our vast system of improved roads is contributing to wider viewpoints, and better understanding of people in different sections.

Land utilized or modified by man-made environment.—Of the various man-made features of the environment, some occupy shore lines, as docks and harbors; some are under water, as ocean cables and dredged channels of rivers and harbor entrances; some are underground, as telephone cables, subways, mines, tunnels, pipe lines, sewers, and drain tiles; some are above ground, as levees, mounds, pyramids, telegraph lines, roads, fences, railroads, bridges, farm buildings, villages, towns, and cities.[4]

Most of them require the *removal of large amounts of rock* or earth, or the *utilization of a large area of land.* (See Fig. 132.) Thus, the Great Pyramid of Cheops, 451 feet high, has been estimated to contain 3,148,000 cubic yards of material, and the Second Pyramid, 450 feet high, at Khafia about ⅔ as much. The dredging of the Mississippi River from 1897 to 1903, involved the removal of 6,129,000 cubic yards of material; and in 1904, the contract to open out the Ambrose Channel from New York harbor to the sea required the dredging out of 42,500,000 cubic yards of sand and gravel, to make the channel 2000 feet wide and 40 feet deep. Before 1898 the government had already removed 32,500,000 yards, and in 1899 a contract called for the removal of 22,000,000 cubic yards of sand and mud from the channel on the east side of the harbor. Of course, these channels were to permit the passage of great ocean vessels into and out of New York harbor. The docks of the Port of London occupy 704 acres with 29 miles of water quays. (See Fig. 134.) The excavation for the London tube (subway) system amounted to 7,143,000 cubic yards, not counting that for the Metropolitan district.

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[4] There are in the United States alone, some 60,000 miles of pipe lines, about 3,000,000 miles of highways, and nearly 8,000,000 miles of telephone toll wire connecting about 70,000 cities, towns, and villages. The total wire mileage of the A. T. & T. Co. is 57,000,000.

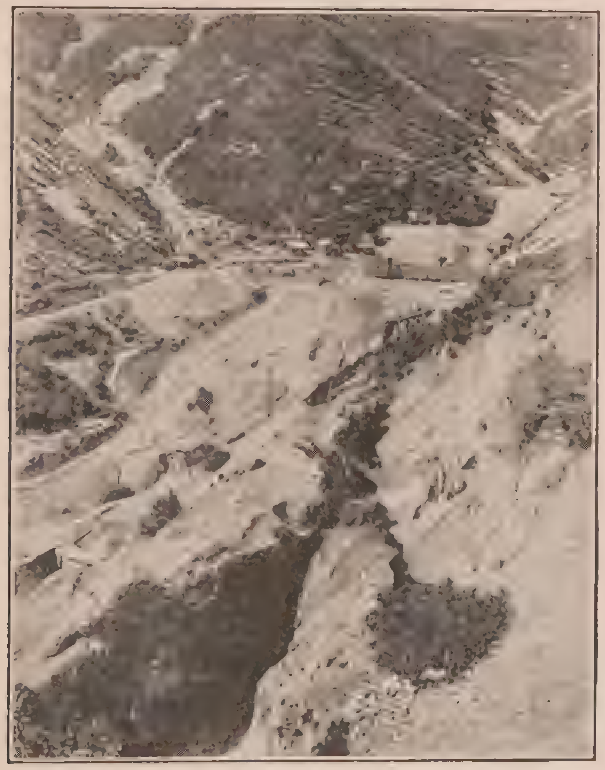
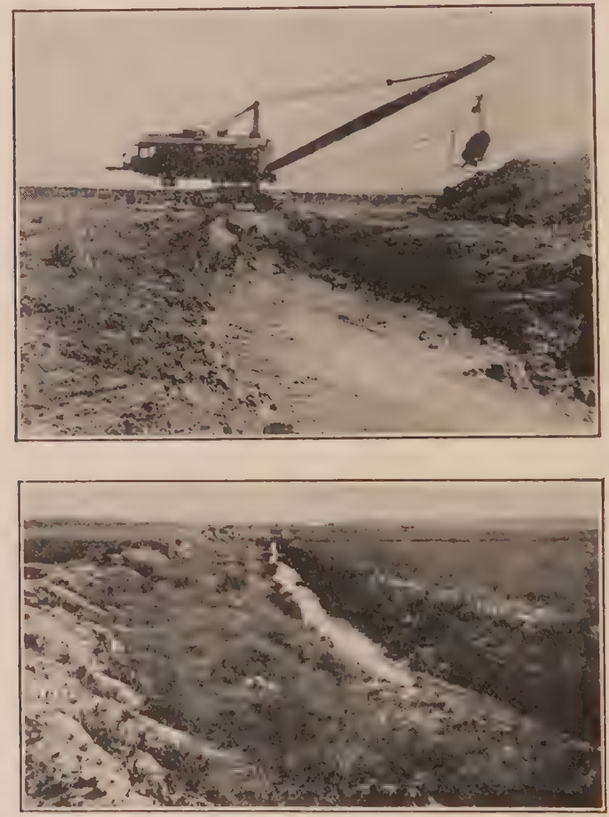


Photo by Keith, U. S. Geol. Survey.

Fig. 132.—The old Jordan mine, Utah. An indication of the amount of tunneling and excavating at different levels beneath the surface is seen in the great terraces of waste material dumped on the outside.

The total *excavations in Great Britain* of all sorts, as mines, quarries, canals, road-cuttings, docks, harbors, etc., were estimated roughly at 40,000 million cubic yards by Dr. R. L. Sherlock in his interesting book " Man as a Geological Agent " in 1922. The same authority states that down to 1908 in South Africa, about 73,500,000,000 cubic yards of the " blue earth," in which diamonds are found, had been taken from the mines. This was piled up in the vast mounds now to be seen near the mines, mostly at Kimberley. If these striking mounds had



Photos by courtesy of the U. S. Reclamation Service.

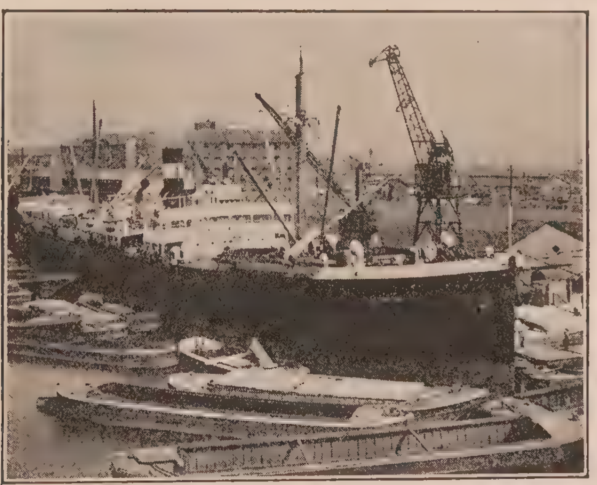
Fig. 133. Modification of Land Surfaces. Reclamation of Swamp Land.

Upper.—The excavation for a drainage canal.

Lower.—Flats on both sides of the drain are now covered with heavy wheat crops. Before the drain was constructed they were immense swamps covered with bulrushes.

been deposited in Ohio by the glaciers, the geology teachers would take their classes to visit them as remarkable environmental formations.

The *roads* of the United States in 1921 occupied 10 million acres of land, according to the estimate of Dr. O. E. Baker, a United States Department of Agriculture authority on land utilization. He also estimates that the railroad rights of way occupy four million acres and our cities and villages 10,000,000 acres.



By courtesy of H. W. Sales & Co., London.

Fig. 134.—One of the many busy docks of the Port of London. SS POLYBIUS of the American Dixie Line, operated for the Shipping Board by the United Gulf Steamship Company, Incorporated, New Orleans, discharging at the Surrey Commercial Dock, London. SS ANTINOUS of the Mobile Oceanic Line is shown aft of the POLYBIUS. These vessels are typical of those employed by the Shipping Board in this trade. In the background is the Surrey Commercial Dock Canadian Produce Warehouse, into which are discharged the perishable foodstuffs and provisions transported from New York to London by the fast express freighters of the American Merchant Line.

Cities and towns.—Cities may be classified according to the leading role they play in national or world affairs. A capital city's function differs from that of a commercial or industrial city. A resort city like Monte Carlo differs from the religious Mecca, the university town like Cambridge, or the international port like Singapore. Within the classes, there is further specialization. Thus, we have Pittsburgh a steel city, Hollywood a film city, Akron a rubber city, and Detroit an automobile city. Then we have the planned city and the "natural" city, according to whether it is the unplanned product of the interaction of successive generations with the environment, as London, England, or whether it is the outgrowth of a plan for a specific purpose, as Gary, Ind. or Washington, D. C. A planned city, however, does not usually grow into a metropolis unless it is found to fulfill an important function in world economy.

As an integral part of the landscape, the city may be regarded in *physical geography* as having not only area but also elevation. The buildings—houses, factories, skyscrapers—rise from the ground, causing changes in wind velocity, temperature, and other atmospheric conditions, much as hills or mountains do. In social geography, the city is looked upon as perhaps the most significant transformation of the natural environment yet made by man. From the point of view of city planners, zoning ordinances, and regional surveys, the expansion of the city is usually thought of in terms of physical growth. Telephone companies make surveys of this environmental factor, the city, trying to forecast the direction of its growth, so that they may extend their lines to meet anticipated future demands for their service.

The concept, *city,* however, includes more than the buildings, parks, and pavements; it also includes the people who live there, work there, and carry on the multitude of activities of modern life that are peculiarly urban. So, it may be said that many of the social problems that are disturbing us to-day, as divorce, delinquency, and crime, are found in their most acute form in our large cities; are closely related to the urban environment, particularly to that of the largest cities. The same thing is true in other countries, as England, France, and Germany.

In England, more than half the population live in cities over 100,000 in size, and the influence of this rapidly expanding urban environment on the lives of the inhabitants is stated by an English writer thus:

> One of the most important and striking developments in the growth of the urban populations of the more advanced peoples of the world during the last few decades has been the appearance of a number of vast urban aggregates, or conurbations, far larger and more numerous than the great cities of any preceding age. These have usually been formed by the simultaneous expansion of a number of neighboring towns, which have grown out toward each other until they reached a practical coalescence in one continuous urban area. . . .
>
> These great aggregates of town dwellers are a new feature in the distribution of man over the earth. At the present day there are from thirty to forty of them, each containing more than a million people, whereas only a hundred years ago there were, outside the great centers of population on the waterways of China, not more than two or three. Such aggregations of people are phenomena of great geographical and social importance; they give rise to new problems in the organization of the life and well-being of their inhabitants and in their varied activities.[5]

The city is a complex growth whose influence extends beyond its boundaries into the surrounding country causing changes in the agricultural system to supply the demands of the urban inhabitants, and contributing to the prosperity, entertainment, and education of the rural population.

The city may be said to be, in a sense, making over human nature and producing its own type of personality. It gives an individual the opportunity to pursue his special occupation and so to develop his particular ability. Thus his latent energies and abilities find expression, and the chance to develop in a favorable environment. As a sociologist expresses it, "The final product of the city environment is found in the new types of personality which it engenders."[6] The means by which man is influenced and changed essentially in the city is largely the system of communication. Newspapers, telephones, mails, and other ways of forming public opinion give the contacts with ideas that, along with close personal and group association with other people, contribute to progress or at least to change.

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[5] C. B. Fawcett, *British Conurbations in* 1921. *Sociological Review,* Apr. 1922, p. 111.

[6] Park and Burgess, "The City," p. 221.

The cities are centers of culture, and ideas spread from these centers to the surrounding country. Through its newspapers, theaters, schools, and museums, through its traveling salesmen and mail-order houses, through its large representation in the legislatures, and through many other points of contact with the inhabitants of the rural periphery about it, the city diffuses its culture over a large area. The city is in this respect an important civilizing agent.[7]

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[7] *Ibid.*, p. 185.

CHAPTER XVII

THE GEOGRAPHY OF CIVILIZATION

The Age-long Preparation of Man's Environment.

Definition and limitation.—The geography of civilization is simply an account of one phase of the evolution of civilization. That is, it has to do with the relations between environment and man throughout the long ages during which he gradually progressed upward, from primitive conditions to those of the highest advancement as represented by the most civilized peoples to-day. Of course volumes could be written merely on the last stage of this progress, that is, on the geographical aspects of present-day civilization. So, to attempt to give in one chapter the whole historical geography of this progress, would simply be to attempt the impossible. This chapter, therefore, merely sketches a few of the steps in this upward climb, only points out some of the mile stones along what seems a remarkably long road over which man has already come. And yet, geologically speaking, mankind has scarcely emerged from childhood.

Biologically, man has developed much the same as the lower animals or the plants, the story of whose age-long development is recorded with more or less incompleteness in the durable rock strata of the earth, which is itself only one small part of the mighty universe.

The science of astronomy indicates that some system of evolution of the universe, the exact nature of which is obscured in the immensity of time and space, has developed in accordance with the laws of nature. Moreover, in the process the origin of the earth is closely connected with that of the parent solar system. In addition geology pictures for us " the changing lines of demarcation between land and sea, the rise and growth of continents, the formation and severance of land-bridges, and the climatic changes which are recorded for geologic time." Then, along with the historical geologist, the paleontologist, or student of ancient life, uncovers the history of living things, both plant and animal, whose gradual evolution from lower to higher forms is recorded by the fossil remains in geological formations.

The coming of man.—Compared with the lower forms of life man is, indeed, a newcomer on the surface of the earth. Just how recent has been man's appearance is indicated by the table on p. 445, which shows the major divisions of geological time and the dominant form of life on the globe during the different periods. The greater time divisions are called eras, and the subdivisions in descending order are periods, epochs and ages. In this table, as in the orderly layers of the earth's crust, the older divisions are at the bottom and the more recent ones at the top.

Paleontological geography.—An examination of the following table of geological and organic changes shows that *a sort of rhythm* seems to have prevailed throughout the ages, and that great changes or advances in life have corresponded more or less closely with the great eras of geologic change. Whether the living things dominant in a given geological era were directly modified by the great environmental changes that took place near or at the end of that era, or whether the creature was modified indirectly through induced habit, or whether nature merely set certain limits or standards to which the organism had to adapt itself or perish, may be matters of discussion. Nevertheless, the fact is apparent, and is demonstrated by the paleontologist, that the stream of life in its pulsations throughout the ages has been quickened by the changing environmental conditions.

Past climatic changes and dominant life.—One of the great causal factors in this evolutionary process among the plant and animal life of the geological records has been that of climatic change. Back of this was the shrinking of the cooling earth, and the consequent warping of the crust with the elevation and widening of the lands and the formation of mountains.

This greater land elevation with its attendant decrease of

THE VERTICAL DISTRIBUTION OF LIFE IN THE GEOLOGICAL SCALE

HISTORICAL TIME (10,000 YEARS).	ERA	PERIODS AND EPOCHS		ADVANCES IN LIFE	DOMINANT LIFE
	Psychozoic.	Quaternary	Holocene. Recent alluvial.	Rise of world civilization.	Age of man. Iron, and Bronze, and New Stone Age. Men of the Old Stone Age.
Geologic Time (100,000,000 years).[1]	Cenozoic (Recent Life) 5,000,000 years.		Pleistocene or Ice Age. Post-glacial stage.	Industry in iron copper and polished stone. Extinction of great mammals. Dawn of mind, art, and industry.	
		Tertiary	Pliocene.	Appearance of lowest form of man.	Age of Mammals and Modern Plant Life.
			Miocene.	Culmination of mammals.	
			Oligocene.	Beginning of anthropoid apes.	
			Eocene.	Appearance of higher types of mammals, and vanishing of archaic forms.	
			Paleocene.	Rise of archaic mammals.	
	Mesozoic (Intermediate Life) 12,000,000 years.	Cretaceous.		Extinction of great reptiles.	Age of Reptiles.
				Extreme specialization of reptiles.	
		Comanchian.		Rise of flowering plants.	
		Jurassic.		Rise of birds and flying reptiles.	
		Triassic.		Rise of dinosaurs.	
	Paleozoic (Ancient Life) 28,000,000 years.	Carboniferous	Permian (another Ice Age).	Rise of reptiles.	Age of Fishes.
			Pennsylvanian.	Rise of insects. (First important coal.)	
			Mississippian.	Rise of marine fishes.	
		Devonian.		First known amphibians.	
		Silurian.		First known land flora.	
		Ordovician.		First known fresh water fishes.	
		Cambrian.		First abundance of marine animals.	Age of Trilobites.
	Proterozoic (Primeval Life) 30,000,000 years.	Algonkian.		Earliest records of life. Primitive aquatic plants and invertebrates developed.	Age of Invertebrates.
	Archeozoic 25,000,000 years.	Archean.		Protoplasm and simplest life.	
Cosmic Time.	Formative Era.	Birth and growth of the earth out of the spiral nebula of the sun. Beginning of the atmosphere and hydrosphere and of continental platforms and ocean basins. No known geological record.			

(After Osborn, Schuchert, Thom, Scott, and Tyler.)

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[1] This is the minimum and is considered wholly inadequate by most geologists, whose estimates vary from one hundred million to one billion seven hundred and forty million years.

temperature, increased perhaps by changes in the amount of solar heat received by the earth at various periods, seems to have resulted in glacial ages at certain periods. Thus a generally accepted cause of the great ice age of the Pleistocene period is a great continental elevation that affected Eurasia and North America in particular. These great cold periods tended to disarrange the whole organic world, and, of course, at such "critical periods" the struggle for existence among the living was very intense. Many times, thus, the dominant life forms which had become adapted to a certain environment, found themselves at a disadvantage and succumbed, *when that environment changed.* Less specialized forms then took their places and, soon adapting themselves to the changed environment, became the leaders in the organic world, only to be replaced by others when another geological revolution occurred.

So the historical paleontological geography tells the story of the rise and fall of amphibians, flying reptiles, and gigantic dinosaurs, until finally late in the age of mammals and modern plant life the *earliest known form of man* appears probably in the Pliocene period or at least in the early Pleistocene, perhaps half a million years ago. With man appears the dawn of mind, and the intellectual possibilities which have made him dominant over the lower animals and plants, and have enabled him to acquire increasing control over nature and natural forces. Now it is man's increasing ability to dominate the forces of nature that constitutes *progress,* an essential element of what we call civilization. So the account of the environmental influences on man during this progress, or of the different ways he utilizes the environment in acquiring this increasing control over nature, may be said to be essentially the geography of civilization.

The Stages in Man's Increasing Control over Nature.

Natural selection and progress.—Man's so-called control over nature is, of course, not absolute. It is really adaptation His power over nature is obtained largely by learning nature's laws, and then conforming to them. Man's adaptation to his environment, however, is not merely physical, it is also mental.

In this respect, man has had a great advantage over the lower animals.

According to Darwin the three main steps in the evolution of species were: *diversity; adaptation; progress.* Diversity is seen in the many variations, mutations, and species of the living world. In other words, diversity is change. It may be either forward or backward. Out of this variety, nature seems to select the fit and eliminate the unfit for survival. That is, a sort of *natural selection* has taken place of those individuals or species that were able to adapt themselves to the changed environment. These have progressed. The others have either been pushed aside or become extinct. Thus, according to Schuchert:

> Paleontology is in the main the science of organisms that were too highly differentiated to adjust themselves to the new conditions that came upon them and which therefore became extinct.

Man's mental adaptation and civilization.—From man's point of view, intellectual evolution is the most important path of progress that has ever been discovered by organisms. The lower plants and animals have been able to escape the fatal sweep of natural selection only by flight or structural modifications, but man has, by his ideas, been enabled to oppose or evade such selective forces, as starvation, disease, and violence, which have threatened to reduce his numbers or prevent his increase.

Lower animals and plants tend to increase in numbers up to the limit of the supporting power of the environment. Then the struggle for existence becomes such that no more can be supported, unless some form of structural modification results from natural selection. In the case of man, however, his intellect may enable him to increase the supporting power of the environment, or he may, by voluntary control of numbers, either postpone the saturation point of the environment or enable the given population to live off that environment with a higher average of well-being.

Thus, on account of the intellectual aspect of man's adaptation to his environment, the above law of increase of numbers must be modified, in his case, by qualifying phrases. Hence, as Keller says, the Malthusian law may be stated:

Human population tends to increase up to the limit of the supporting power of the environment, *on a given stage of the arts, and for a given standard of living*—that is, for a given stage of civilization.

One must not lose sight of the fact that the type of environment itself has often been changed by the increase and concentration of population and by the resulting development of civilization. By civilization, energy is freed from the mere struggle for existence, where the limitations of the environment seem to control the man; and this surplus energy may be used for artistic creations, which may or may not reflect environmental influences. On the other hand, it may result in higher reasoning, such as politics, ethics, philosophy, or science, the success of which may in part, but certainly must not entirely, be attributed to the influences of environment. Nevertheless, although civilized man's multiplication of the contacts with nature has seemed relatively to weaken the force of each, and his contacts appear more and more at second hand, yet as Kelsey expresses it,

> in the qualities of the elements of the earth and man's adjustment thereto, is the basis and start of all man's vaunted achievements as well as the limits thereof.[2]

Probable original home of earliest man.—Biologically, man belongs to the order of *primates*, a group of mammals, which is now thought to have originated in the great continent of Eurasia, from which center migrations extended gradually outward along the several continental radii. (See Fig. 135.) Thus, of the lower animals most resembling man, the *anthropoid* or manlike apes, the gorilla and chimpanzee left the original home in Central Asia and departed southwestwardly towards Africa, while the orang and the gibbon went toward the southeast. Each of these four anthropoids, reaching the tropics with its enervating languor, seems to have progressed no further, if indeed they did not retrogress.[3]

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[2] *The Physical Basis of Society,* Chap. I.

[3] Anthropologists tell us, however, that none of the fossil anthropoids, either of Europe or of Asia, can be regarded as ancestral to man.

The *original ancestors of man,* however, seem to have remained longer in Central Asia, which at that time was not the high desert that it is now, and where in fact it is probable that large forests permitted an arboreal life. The geologists tell us that, in Miocene times, a great continental uplift, resulting in increased aridity in the interior of Asia, developed the great barrier of the Himalayas, cut off the forests of Central Asia from those of India, and severed the lines of migration by which the anthropoids had left the cradle of their species.

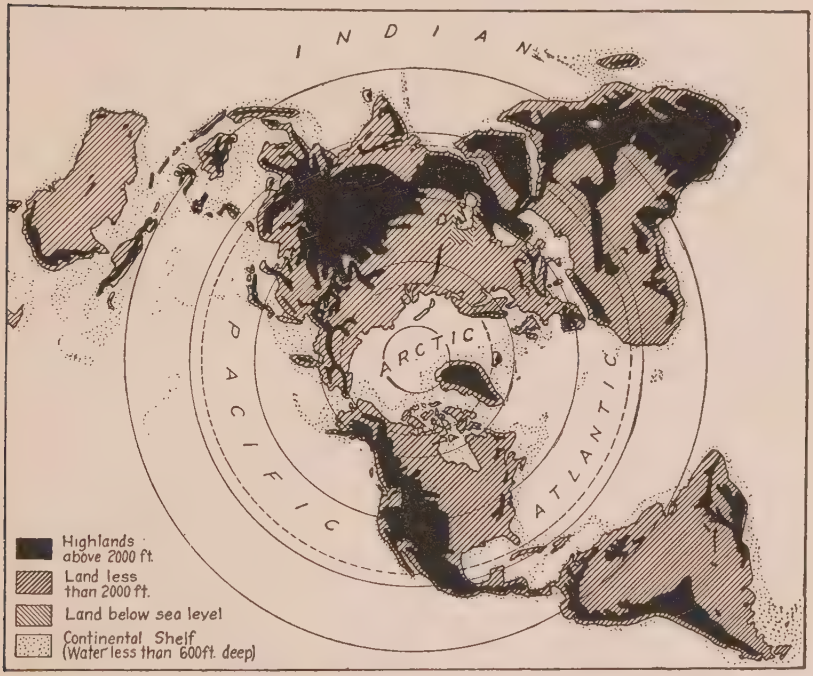

Fig. 135.—Map to Illustrate the Central Position of Eurasia with Land Radii Extending toward the Southern Tips of Australia, Africa, and South America.

The *increasing aridity* and resultant *dwindling of forests* of Central Asia, in Pliocene times, compelled the immediate progenitors of primitive man to abandon their tree life to get a living. Consequently the competitive struggle with carnivorous beasts of the field required the use of clubs, stones, and other weapons in the hands which they formerly used to climb trees and swing from limb to limb.[4] The quickened wits necessitated by this *struggle for existence,* in which failure meant death, were further stimulated by the increasing severity of the temperature as the Glacial Period approached; and to keep warm, the skins of the slain beasts were doubtless utilized, and finally the use of fire marked another step in the upward social development. Even at that early date man was gregarious, that is, social, and primitive coöperation helped him slowly to acquire dominion over the organic world and to begin to conquer the forces of nature.

Primitive man in the hunting stage.—Human existence depends upon the utilization of the facilities offered by nature. Civilization is possible only by the direction or control of these facilities for man's benefit. Man's control of nature consists in the use of natural materials and forces to accomplish his purposes; during long ages this dominance did not exist. Primitive man lived in groups and fed on fruits, nuts, shellfish, insects, or other food easily obtained, with occasionally a feast if some large animal were accidentally killed. It was an important epoch when he discovered the possible uses of a club or stone, for it marked the beginnings of his control over nature which has resulted in civilization. After his invention of the drill for making fire, more ages passed before he found easier ways. Many of his discoveries were doubtless accidental, but each step that improved his mode of life also gave him a better mental notion of the possibilities of the situation and so stimulated further discovery. Without doubt, the opportunities of his environment influenced his forward march.

But, all in all, *savage life presents a dark picture.* Primitive man is usually a miserable, underfed, undersized, unclothed, houseless creature, in continual terror of dangers visible or invisible, with no family ties, as we think of them, and no settled home. Yet the savage hunter, his very existence dependent on his success in the hunt, learns to endure hardships without complaint. Always on the lookout for danger he develops keen powers of observation, and such things add something at least to the progress of civilization.

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[4] In regard to the psychic developments of this period, Elliot Smith observes that the arboreal mode of life of the early ancestors of man developed quick, alert, and agile movements, which stimulated the progressive development of the posterior and lateral portions of the brain. Life amidst the branches of the trees is most favorable to the high development of the senses of vision, touch, and hearing. Moreover, it demands an agility and quickness of movement that necessitated efficient motor centers in the brain to coördinate and control such actions as tree life calls for. The specialization of sight awakens curiosity to examine objects with greater minuteness, and guides the hands to more precise and skilled movements. (See Osborn ''Men of the Old Stone Age,'' p. 56.)

Distribution of mankind.—From the central Asiatic home of his immediate ancestors, primitive man gradually spread to other continents and to most oceanic islands. Influenced by much the same stimuli, for example, cold and hunger, and guided by the same natural laws and barriers as the lower animals, he reached Africa by the Isthmus of Suez and proceeded clear to the Cape of Good Hope. He penetrated the Americas even to Cape Horn, by way of Bering Strait and the Isthmus of Panama. The aborigines reached Australia and Tasmania (See Fig. 135.), by the East Indies, and the land bridge that during a period of continental uplift connected Australia with Asia.

The first migrations must have taken an exceedingly long time, and during the *ages-long dispersal* into regions of vastly different environmental characteristics, many changes must have taken place in the human stream. Intermarriages and blendings, or climatic influences, must have resulted in many variations among the hordes, packs, tribes, clans, or other social organizations that developed. Among these variations, some would be better suited or adapted to the different environment than others, and natural selection probably resulted in their survival and the increase of their offspring.

In some such way, the various types, races, stocks, and peoples must have originated. The migrating races are usually conquering races, and as successive waves of migration followed, the weaker or less well-adapted people were usually forced to the side or to less desirable habitats, or were doomed to extinction. Modern savage groups occupy relatively barren, inhospitable, or inaccessible regions, into which they have been crowded by stronger peoples. Thus, far from the supposed center of original migration in Asia, we find the most primitive peoples to-day; the Blackfellows of Australia, the pygmies of Africa, and the Fuegians of South America.

And thus, about 100,000 years ago the so-called *Neanderthal man* appeared in Europe. He must have been a wanderer, for his bones have been found not only in Europe, but also in Africa and Palestine; and in 1925 the American Museum of Natural History expedition, under Roy Chapman Andrews, found crude stone implements distinctly of his make on the plains of Mongolia. These stooping, heavy-browed men were evidently hunters and cave dwellers in Europe, where their remains were first discovered. They fought the mammoth, the bear, and the rhinoceros with spears and weapons of the rudest make. They dressed skins for clothes, spoke some sort of language, had fire, and buried their dead.

That the remains of Neanderthal man with his accompanying culture have been found in Palestine, Northern Africa, and Europe, strengthens the theory that his original home was in Asia, and that from there he reached Europe by way of the Isthmus of Suez and Northern Africa, probably during the Glacial epoch. He was a member of the genus *Homo*, but of a species now extinct, *neanderthalensis*. Other races also have risen and disappeared but at the beginning of the historical period, about 10,000 years ago, the three types, yellow, black, and white, with their various races existed very much as they do to-day.[5]

Successive steps in prehistoric man's control of nature.— During prehistoric times, man made successive advances in his struggle to bring the forces of nature under his control. These are indicated by the *cultural levels*, to which we generally refer as the Paleolithic Period or Old Stone Age, the Neolithic or

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[5] Anthropologists recognize at least five species of the genus *Homo*, four of which had become extinct before written history begins; namely, the Heidelberg man, the Piltdown man, the Neanderthal or Monsterian man, and the Rhodesian man. These were named after places where their fossil remains were found. Of the present species (Homo sapiens), at least one race variety, the Cro-Magnon man, flourished and became extinct in prehistoric times. The famous *Pithecanthropus erectus* can not be assigned to the genus *Homo*, nor to any genus of living apes.

New Stone Age, and, somewhat more advanced, the Bronze Age.[5a]

Neanderthal man was in the *old stone age* of cultural development. He had attained some skill in chipping flints, which classifies his culture as that of the lower paleolithic. Races before him, using tools, implements, and weapons of stone, or sometimes of bone, so lightly modified as hardly to be recognized as implements, are said to have had the most primitive type of culture, called the *eolithic* or dawn stone culture. Later peoples somewhat more advanced than Neanderthal man in the working of stone had what is called the *upper paleolithic* or later stone culture. The old stone age with its unpolished stone implements was followed by the *neolithic* with its tools and weapons of more finely chipped and highly polished stone. This brings man down close to the beginning of historic time.

The *neolithic period* was one of the most significant of all for the human family. The men of that period knew how to raise cereals; they had some domestic animals; they could spin, weave, sew, and make pottery; they made "dug out" boats, by hollowing out logs with fire and stone tools; and they even discovered the advantage of rollers under their sleds or "stone boats" used on land. This primitive wheel was very significant for later transportation and industry.

Data regarding that culture comes from floors, walls and ceilings of cave dwellings; from refuse heaps on lake bottoms, above which dwellings of wood were built on piles; from flint stations, where they got the stone and made their implements; from stone burial places, often covered by immense mounds of earth; and from the "kitchen middens," or shell heaps, like those neolithic evidences of food supply left in Tierra del Fuego and along many coasts throughout the world. Some of these kitchen middens on the coasts of Denmark are nine hundred feet long, up to two hundred feet wide, and as much as ten feet thick. These, like archæological remains in general, indicate social congregation among prehistoric men, and point to a direct connection of natural food supply with human association.

[5a] Sometimes the Age of Copper is included after the New Stone Age; while it was progress when primitive man found that copper could easily be hammered into tools and weapons, it did not differ greatly from the Stone Age, for, owing to the softness of the copper, the tools could not be given a lasting edge. When man discovered that by adding an alloy of tin to the melted copper a harder substance resulted, he entered the Age of Bronze.

Civilization a function of numbers.—The earliest archæological remains, however, do not disclose the *earliest associations of men.* Men who had not advanced beyond the use of sticks and unchipped stones left no archæological remains. The association of the earliest men, like that of many savage groups or "packs" to-day, must have depended on the abundance and accessibility of the kinds of food that could be obtained by hands using only sticks or stones.

These early groupings of men, however, bore the germs of future civilization; for civilization is a product of numbers and of the contact of numbers, as they progressively utilize the materials and forces of nature in their endeavors to gratify continually expanding human wants. No civilization of any importance has ever been developed or could be developed by individual, or even by limited group action, in isolation. People must come together so that mind can react on mind. Then out of the contact and conflict of ideas, the variations, as the evolutionists might say, may be sifted and the best adaptations be preserved. *Man's adaptation to his environment* is not only *physical* and *mental* but also *social.* Thus in the development of human activities and relationships the first sign that civilization is appearing is the concentration of people in certain regions. When the hundred thousand years or so of the lower Old Stone Age rolled slowly away, the retreat of the glaciers during the upper Palaeolithic times ushered into Europe a new people, the Cro-Magnon race, which seems to have very largely replaced the earlier Neanderthal cave dwellers. The physical and mental qualities of this new race are the wonder and admiration of all students of the prehistoric period, yet he was merely the noble savage still in the hunting stage of social evolution.

Agriculture and the domestication of animals.—Not until a mingling of peoples, coming from east and south into Europe, do we find there the advancing culture which marks the appearance of the New Stone Age, some 10,000 or 12,000 B.C. The explanation of the progress, then, seems to lie in the *introduction of agriculture,* the real basis of civilization. The social geography of this lies in man's changed method of utilizing the land, and in the growth and development of social life. In the rise of neolithic culture the individual played a very subordinate part. It was a tribal movement. Division of labor was beginning. There were centers of mining and making of flint implements, workshops of pottery, weaving, and so forth; even some manufacture of jewelry from amber and other things. That meant some interdependence between groups in different areas, as evidenced by the rise of trade routes and the bringing in of new patterns, influences, and ideas. The introduction of agriculture and the increase of population fostered coöperation. The agriculturist lived in a village and had neighbors.

The typical development of this neolithic culture arose earlier and lasted longer somewhat aside from the great routes of trade and migration; and it arose earlier in Asia than in Europe. Along the north side of the Caucasus Mountains and the shores of the Caspian and Black Seas, in the great route of trade and migration between the grasslands of Central Asia and Southern Russia, isolation being impossible, change went on more rapidly. The grasslands were better suited for raising cattle and sheep than for agriculture. Here, at least 2000 B.C., the horse was domesticated, and very early we find there a mixed and diversified population, which made rapid progress somewhat owing to the influences coming up from the Mediterranean by way of the Black Sea and its rivers.

Other *areas of concentration* of population were formed still earlier along the *banks of rivers,* such as the Nile, the Tigris and Euphrates, and the great rivers of India and China, which thus gradually became centers of civilization. In fact, the dawn of history begins with such concentration on alluvial river banks. Another step, in historical development, sees centers of population, with the accompanying cultural advance, along the *shores of inland seas,* such as the Mediterranean and the Baltic. Next we find great nations developing *along the Atlantic Ocean,* and perhaps finally, the great civilizations may concentrate about the greatest ocean, the Pacific.

The point to be noted here is that in all history and social progress it is aggregations of people, contacts, and opportunities for communication that mark the advances in civilization. These are social facts, not individual. In each case, also, the influences of environment are obvious. These are geographic facts. Consequently they are matters of social geography. It is not meant by this that social geography accounts for all human progress. It merely means that in all human activities, whether in the past or in the present, social geography must be considered because it can contribute, not all but part of the explanation. Its function is the study of man, his distribution, and his activities, in their relation to the various environmental factors.

Half-civilized man's efforts to control nature.—It has been said that uncivilized man finds things, but civilized man makes things; and, at least from the material point of view, civilization consists largely in wanting many things and in learning how to make and use them. As food is a primary need, primitive man, in the hunting and fishing stage, not having learned how to make or raise it, has to depend on what he can find. Thus, primitive forest bands or "hordes" of Brazil live on roots, bulbs, nuts, grubs, insects, and birds' eggs. Early man must have existed in much the same way at first. But such food could not have counted for much. He must have sooner or later lived chiefly on game or fish, according to locality. Hunting doubtless was the first thing in which he acquired skill. (Fig. 136.) Fishing, on the whole, required even more skill and tools. So, such tribes, as a rule, were slightly more advanced. But as long as man depended only on what nature provided, population was sparse, poverty extreme, starvation common, and war and cannibalism a natural result among small and scattered tribes.

Beyond the hunting stage, it *depended on the environment* chiefly whether man "raised" his living in the form of animal or vegetable food, that is, whether he entered next the pastoral or the agricultural stage. Both represent man's utilization of his biological environment. Both represent steps upward in man's increasing control of nature, whether it be looked upon from the point of view of economic geography or of political geography. Economically, both meant a better and more reliable food supply. Politically, it is believed that the domestication of animals converted the savage pack or horde into the patriarchal tribe; and that the adoption of agri-

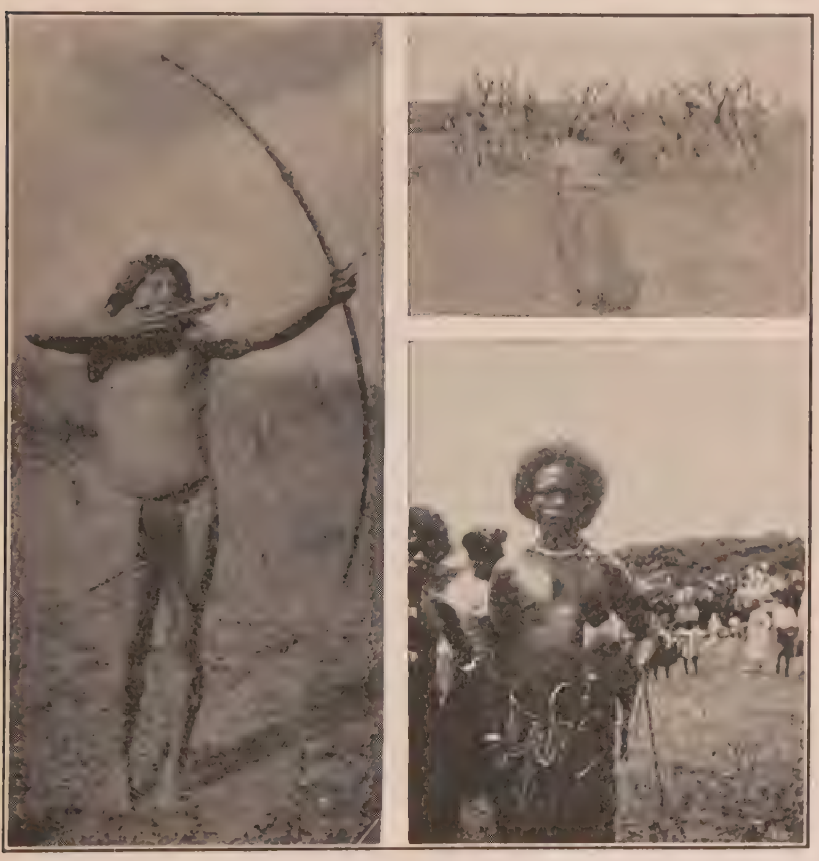


Fig. 136.

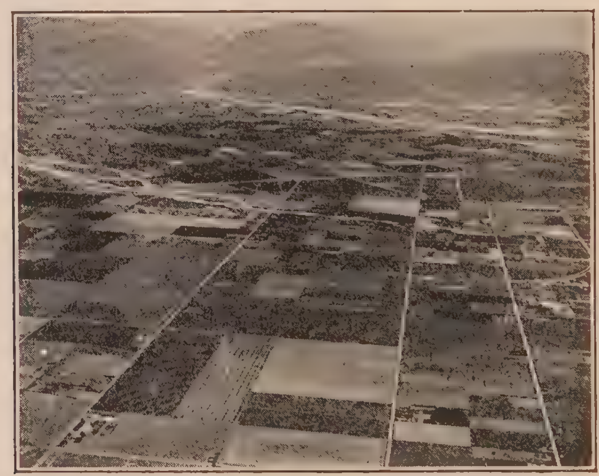
Left.—Indian hunter, interior of Brazil.

Lower right.—Papuan native with pig, near Port Moresby, New Guinea. These natives are coast dwellers and have come into contact with missionaries and officials, but those in the interior are still savage.

Upper right.—A grassland dweller near the edge of the desert. Bechuanaland, South Africa. A cow pen in the background. (Photos by C. C. H.)

culture broke up the tribe into clans. Thus, man's method of utilizing his environment early began to have both economic and political consequences.

The pastoral stage.—It was, in a way, more natural for the domestication of animals to come next after the hunting stage, as it requires similar personal qualities and modes of living. Where suitable animals to domesticate were lacking, the pastoral stage in social evolution was skipped and agriculture usually followed, though generally delayed somewhat. Thus, in North America the Indians had no cattle, and, failing to domesticate the buffalo, were, when the whites came, in various stages of transition between hunting and agriculture.



Courtesy of the Transcontinental Air Transport, Inc.

Fig. 137.—Intensive land utilization in modern advanced forms of agriculture. Orange groves and other irrigated crops of the Los Angeles Valley, Southern California. Note the bleak and barren hills in the background.

Of course the *grasslands* of the world are especially favorable to the pastoral industry, but frequent shortage of rainfall and, generally, its seasonal character in such regions made tribal migrations with flocks and herds common from the days of Abraham and Isaac to the present, as illustrated by the Kirghiz of Central Asia or the Bantus of South Africa. So the patriarchal society cared little or nothing for residence or locality. Its bond of union was personal, not territorial. Thus, each of the sons of Israel became the founder of a tribe. To be a member of a particular group, a man had to be of the blood of that group. In modern society, on the contrary, social allegiance is determined rather by residence in a fixed area.

Results of pastoral stage.—As the advantages of rearing instead of killing animals came to be realized, the savage horde gradually changed to a society of shepherds or herdsmen, where the men tended the cattle, sheep or goats, while the women did the subordinate work of spinning, milking, or making butter and cheese. In these tasks the men soon saw the value of labor; the need of more men to watch and care for the cattle, and of women and children to perform the domestic labor. So, the student of politics suggests, to this demand for labor we probably owe two important social institutions of the pastoral stage—*permanent marriage* and *slavery.* The first arose from man's desire to secure exclusively for himself the labor of the woman and her offspring; the second came from the practice of keeping alive, instead of killing, the captives taken in war. Slavery thus seems a step upward, for, bad as it is, it is better than cannibalism.

Another contribution made to the progress of civilization by the domestication of animals was an *increase in the numbers and physique of the population,* on account of the greater abundance and regularity of the food supply and the increase of clothing and shelter. Tribes soon came to differ in strength and importance, too. Differences in climate and skill in rearing animals soon produced differences between households and tribes. Some became wealthy, some remained poor.

So, the economists tell us this time, to the domestication of animals largely should be attributed two other ideas very important in present civilization—*profit* and *capital.* We think of profit as the net gain in business, but originally it was the offspring of domestic animals. The cattle, themselves, when *saved* instead of killed were found to yield a continual income, whether in offspring, milk, or both, just as capital yields income. So their wealth was expressed as so many *head* (Latin, *capita*) of cattle, for example. In fact, our word pecuniary comes from the Latin word (pecunia) meaning cattle.

Man's *increased control of environment* in the pastoral stage resulted in wealth, because it permitted a surplus over mere subsistence. Wealth is one great prerequisite of civilization. When man had to use all his time and energy to get the bare necessities of existence there could not be much progress.

The agricultural stage.—It is very likely that agriculture in a very primitive form was practiced as early as the pastoral pursuits. Even now very primitive agriculture is common in many places. Hoe culture is general among the primitive cultivators of South America, Central Africa, and the Indonesian Islands. But in the development of human industry, agriculture takes rank distinctly later and above the pastoral stage. In the first place, it is much more laborious; and primitive or even half-civilized man did not love work for its own sake. Thus the Biblical curse was often on the tiller of the soil. "In the sweat of thy face shalt thou eat bread." So, agriculture, for ages after it was practiced in a primitive form, did not become a substantial occupation of man. It came in on a large scale only when the growth of population began to cause pressure on the food supply. While agriculture is hard work, the striking fact about it is that its produce is immensely greater than that from pasturing the same amount of arable land.

Agriculture on a large scale was *early developed in the delta of the Nile* and on the rich alluvial lands of the Tigris and Euphrates valleys, where near-by desert lands afforded but little pasturage for cattle, and thus there was less danger to the settled farmers from raids by tribes of roving nomads. From there, it probably spread through Asia Minor northward and westward until it was known and adopted throughout Europe as the needs of the population required it. By the end of the Middle Ages, agriculture had progressed step by step until the village community system of farming was the typical form not only throughout Europe, but also among the vast populations of Egypt, Persia, and India.

In the pastoral age, there was no permanent division of the land among the individual families of the tribe. Each man's share of the tribal land was counted in cattle or sheep. But, under agriculture, it soon came about that a family that cleared and farmed a given plot of ground became loath to part with it. So, agriculture meant not only a different and *more economical form of land utilization* than pasturage, but it meant a larger, more peaceful, and more settled population, each indicative of advancing civilization. It gave rise to the institution of private property in land, to land rent, to more permanent houses and a higher form of architecture. It established the division of labor within the family on a more stable basis, and raised the status of woman, whose economic importance was less in the pastoral stage. Permanent agriculture was indeed a great civilizing influence. It encouraged social progress. It fostered the spirit of coöperation, particularly where irrigation was necessary and numbers had to work together for common ends. It made possible the accumulation and storing of food supplies and surplus wealth. It fostered habits of foresight, patience, and labor, and bred conservatism. Its practice led to the recognition of the need of security and the establishment of a more stable form of government. Elliot Smith says:

> In the whole history of mankind no single factor has had an influence so great and so far reaching as the invention of the art of agriculture, which represents the beginning of real civilization.

Irregular development of the historic stages of society.— The stages of social development, which mark man's continually increasing control over nature, have not been a straight and smooth advance from hunting and pastoral, to agricultural and manufacturing life. The advance has in fact been irregular, largely *according to the characteristics of different regions;* and peoples have not always passed through these stages in logical sequence. Thus, North America missed the pastoral stage, and passed directly from hunting and fishing to agriculture; the big game animals, such as deer, bears, and buffaloes, not being easily domesticated, and a field product, corn, being of great utility and easy cultivation.

In other places, the domestication of animals has so long continued the dominant occupation that it has kept alive the *roving habits of nomadism* and often stimulated it to dangerous excesses. History vividly records the successive waves of Central-Asian nomads, that pressed westward to Europe and the Mediterranean under leaders such as Attila the Hun, Ghengis Khan, and Tamerlane. These great migrations, influenced by the increasing drought and the overcrowding of men and cattle in their homeland, were usually not stopped till they reached the western limits of the grasslands extending in a great wedge from Central Asia to the plains of Hungary.

On the other hand, in the *moist or irrigable lands of southeastern Asia,* and the East Indies, we find to-day a congregation of over half the human race, made possible largely by the adoption of intensive agriculture and the rotation of legumes and other crops, which are characteristic of rice growing. The cultivation of rice goes along with great density of population, a high birth rate, much hand labor, a lack of animal raising, and a largely non-meat diet. In this respect it is in strong *contrast with the North American and South Temperate zone standards* of land utilization, based largely on wheat cultivation, work animals, agricultural machinery and industries.

The industrial stage of social progress.—The great stimulus to industry originally came with the development of agriculture, which brought a demand for hoes, mattocks, sickles, scythes, and plowshares. Primitive implements, as we have seen, progressed from sticks and shells to rough, chipped, and polished stone, but no great progress in agriculture could be made until metal tools were used. The development of the *art of working in metals,* in fact, is one of the most important subjects in the geography of civilization. Thus, technologically, the ages of stone and bronze are said to be succeeded by those of iron and of steel, and the present is often said to be merely the beginning of the machine age.

Even pastoral races have some knowledge of working in metals. Thus, numerous bronze relics of great antiquity are continually being dug up by archæologists; while the brazen helmets and armor of the Homeric heroes, their weapons, the money of the Jewish patriarchs, and the gold and silver ornaments of African tribes all indicate how ancient was the beginning of the art of metal working.

Those, however, were all soft metals, capable of being hammered out, while cold, with a stone hammer. It was revolutionary, however, when man learned to work with iron, which though malleable when smelted in fire, is afterward immensely harder than the earlier metals used, and much more effective. Modern industry may be said, then, to begin with the important craft of the smith, from which in fact most of the other crafts have sprung. The importance of this craft is suggested perhaps by the number of people to whom it gave its name (Smith in English, Schmidt in German, Favre in French, and so forth). Other crafts, branching off from this, such as carpenters, shoemakers, tailors, wheelers, turners, coopers, weavers, bakers, and brewers, also provided many family names, and bear witness to the growing importance of industry.

Commerce and the division of labor.—Specialization in industry and division of labor,[6] however, were dependent upon trade, for production without exchange could not proceed very far, as no one would want to work to produce a surplus which he could not dispose of. Consequently, industry and commerce go hand in hand. *Geographical division of labor* between cities, regions, or countries is possible and profitable; because commerce enables products adapted to one region to be produced in excess of the needs of the people there, and then to be exchanged for the surplus of another region, with quite different industrial possibilities and development. Trade at first was chiefly barter (the exchange of goods directly for other goods); but soon the need of some medium of exchange arose, and then some generally acceptable commodity, as skins, shells, cattle, or tobacco, served as the go-between in the trade. Finally money, usually of gold, silver, or paper, and still later credit,[7] tremendously facilitated the growth of commerce.

The growth of cities.—Agriculture, both in Asia and in

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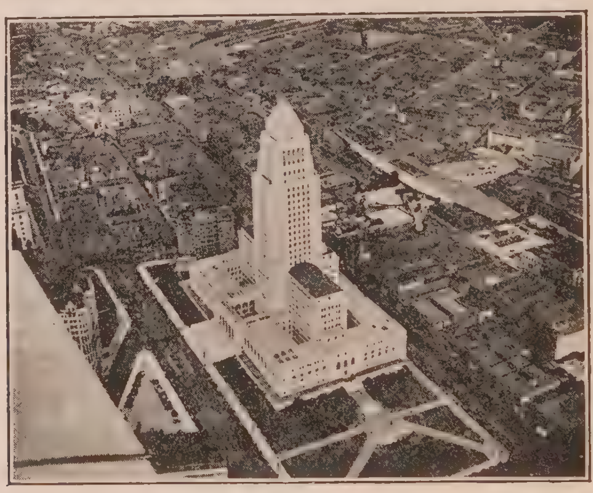
[6] By division of labor is meant the system by which one group of workers in a business establishment, an industry, or a region, specialize on one thing, other groups doing other things.

[7] By credit is meant the right to receive goods in the present, in exchange for a promise to pay for them in the future. Credit transactions are evidenced, for example, by checks, drafts, bills of exchange, promissory notes, and charge accounts.

Europe, resulted in many village communities, for protection, coöperation, and sociability; but they tended to remain small, for agriculture requires the population to be scattered. Manufacture and commerce, however, have the opposite tendency. Manufacturing, since its change from the household and village industries (like spinning, weaving, and shoemaking) of a hundred and fifty years ago to the modern factory system, requires concentration of population, division of labor, and trade; therefore the *environmental conditions which favor trade and transportation* are important in promoting the development of localities and regions adapted to manufacture. As we have seen in Chap. XII, commerce and industry are the great city builders of the modern era, and the greater of these in its influence on urbanization is industrialization. Now, our modern industrial civilization is based largely on minerals, power, and energy; and man's control of these is, to a great degree, dependent upon the fuel resources of his environment and upon his ability to utilize them.



Courtesy of the Transcontinental Air Transport, Inc.

Fig. 138.—The modern city with its skyscrapers depends on transportation. TAT plane flying over Los Angeles, California, showing the new city hall in the foreground. Note the rows of automobiles at the left, the street railways around the central square, and the railroad tracks and cars in the background.

Coal, iron, and petroleum.—Just as, in prehistoric times, man's struggle to bring under control the forces of nature gave rise to the cultural stages known as the old and the new stone ages and the age of bronze, so the modern period is variously designated as the age of coal, iron, steel, or petroleum. Not till some two or three thousand years ago, when man learned to smelt iron, did he make great progress industrially. While iron is a very common metal, it is so important and universally used because of its strength, hardness, ductility, and magnetic properties. With iron and the still *harder* steel made from it, man has been able to make tools and machinery, hard, strong, and durable enough to permit clearing forests, plowing heavy sod in grasslands, digging mines, and constructing tunnels, railroads, locomotives, automobiles, and ocean steamers.

It is an accepted fact that we of the western world, at least, are living in a "machine civilization." The machine has made mass production possible, thus tending to reduce the unit cost of making commodities. Thus the world's wealth per capita has been increased. This has made possible a more equal distribution of wealth; it has contributed to a higher wage standard, and a higher average standard of living for the inhabitants of industrial countries. Modern industrialism has offered man greater safety and comfort, and wider opportunities for development.

Of course the extent of the chief *material resources and their probable duration are vital factors* tending to fix the direction and, in the long run, tending to limit the growth of our present type of machine civilization. As for the United States, although our coal and iron resources are not nearly exhausted, yet we have doubtless passed the point of maximum cheapness for both. Even with all efforts towards conservation, they will be scarcer and dearer, as also will iron and steel products. The period during which petroleum will be of serious industrial importance will doubtless be relatively brief, and so will not greatly change this result.

Our success in meeting the rising costs of mineral products will turn on our *ability to command greatly increased amounts of energy.* Of the sources of energy available at present, coal and oil are by far the most important. Man's ability to control and utilize these is, from the geographical point of view, both a distinguishing characteristic and a basic factor of modern civilization. Recent world events reflect improved methods of using mineral fuels, and international intrigues and struggles to control one or both of these " keys to the future."

Ninety per cent of the *world's reserves of coal* are in the northern hemisphere and over two-thirds of the supply is in North America. The two most *important oil-bearing regions* are: (1) the United States and the regions surrounding the Gulf of Mexico and the Caribbean Sea; (2) Southeastern Europe and southwestern Asia adjacent to the Black and the Caspian Seas and extending through Mesopotamia into southwestern Persia. That these two greatest known sources of the basic energy resources of present day civilization are *controlled chiefly by Great Britain and the United States* suggests the necessity of a choice between shortsighted and suicidal rivalry, or close coöperation, between these great peoples. If this brief sketch of the geography of civilization has given the student some appreciation of the continually upward trend in man's control or utilization of his environment, he will expect the choice to be international coöperation.

The position and *responsibility of these two great commonwealths* is indicated by the following quotation from Professor W. T. Thom of Princeton University:

> Accident or destiny has made the English-speaking peoples of the world the principal actors in the present drama of civilization, and as long as they work together, and deal moderately and justly, both in their foreign relations with other peoples and races, and in their own domestic affairs, just so long will our modern civilization survive.[9]

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[9] ‘‘Petroleum and Coal: The Keys to the Future,’’ 1929, p. 210.

APPENDICES

APPENDIX A

COMPARATIVE WORLD STATISTICS[4]

CLIMATE AND POPULATION

Climatic Conditions: Important Cities of the World

COUNTRY	CITY	LATITUDE AND LONGITUDE	ELEVATION	MEAN TEMPERATURE			PRECIPITATION		
				January	July	Annual	January	July	Annual
		° °	Feet	°F.	°F.	°F.	Inches	Inches	Inches
United States	Atlanta	34 N. 84 W.	1,218	43	78	61	4.7	4.4	49.3
	Chicago	42 N. 88 W.	824	24	73	49	2.1	3.4	33.0
	Denver	40 N. 105 W.	5,292	30	72	50	0.4	1.8	14.3
	Kansas City	39 N. 95 W.	963	30	78	55	1.2	4.2	36.8
	Los Angeles	34 N. 118 W.	361	55	70	62	3.3	(1)	15.6
	Minneapolis	45 N. 93 W.	918	13	72	45	1.1	3.5	29.0
	New Orleans	30 N. 90 W.	51	54	82	69	4.5	6.6	56.6
	New York	41 N. 74 W.	314	31	74	52	3.3	4.1	42.2
	Seattle	48 N. 122 W.	248	40	64	51	4.8	0.7	33.9
	Washington	39 N. 77 W.	75	34	77	55	3.2	4.4	40.5
Algeria	Algiers	37 N. 3 E.	125	53	77	65	4.2	0.1	30.0
Argentina	Buenos Aires	35 S. 58 W.	72	74	49	61	3.1	2.2	37.9
Australia	Adelaide	35 S. 139 E.	141	74	52	63	0.8	2.6	20.6
	Melbourne	38 S. 145 E.	115	68	49	58	1.9	1.9	25.6
	Perth	32 S. 116 E.	197	74	55	64	0.3	6.4	33.3
Austria	Vienna	48 N. 16 E.	666	29	67	49	1.4	2.8	24.6
Belgium	Brussels	51 N. 4 E.	131	34	63	48	2.2	3.1	29.6
Bolivia	La Paz	17 S. 68 N.	12,300	52	45	49	3.9	0.2	21.2
Brazil	Manaos	3 S. 60 W.	131	78	79	79	9.8	3.1	83.7
	Recife (Pernambuco)	8 S. 35 W.	10	81	75	79	3.0	14.0	78.9
	Fortaleza (Ceará)	4 S. 38 W.	89	80	77	78	4.9	1.0	58.2
	Rio de Janeiro	23 S. 43 W.	197	78	68	73	5.0	1.6	43.4
	Maranhão (San Luiz)	3 S. 45 W.	(2)	80	79	80	7.7	4.5	84.7
British Guiana	Georgetown	7 N. 58 W.	6	78	79	80	7.6	9.7	86.9
British Malaya	Singapore	1 N. 104 E.	6	78	81	80	9.0	7.0	93.0
Bulgaria	Sofia	43 N. 23 E.	1,804	27	69	49	1.5	2.7	25.5
Canada	Montreal	46 N. 74 W.	187	13	69	42	4.0	4.0	40.3
	Vancouver	49 N. 123 W.	72	35	63	49	8.6	1.3	60.6
	Winnipeg	50 N. 97 W.	760	−3	66	35	1.0	3.2	20.7
Central America	Belize	17 N. 88 W.	6	76	82	80	7.4	8.2	84.5
	Panama	9 N. 80 W.	(2)	80	80	80	1.0	7.6	69.4
Ceylon	Colombo	7 N. 80 E.	23	79	80	80	3.2	4.5	88.3
Chile	Antofagasta	24 S. 70 W.	16	69	55	62	(1)	(1)	0.2
	Santiago	33 S. 71 W.	1,706	69	46	57	(1)	3.1	14.1
China	Peking	40 N. 116 E.	125	24	79	53	0.1	9.4	24.9
	Sanchoei (Canton)	23 N. 113 E.	33	58	84	72	1.5	9.3	69.2
	Shanghai	31 N. 121 E.	23	38	80	59	2.2	5.5	44.0
Colombia	Bogotá	5 N. 74 W.	8,579	58	57	58	3.7	2.6	63.4
	Cartagena	11 N. 75 W.	15	(3)	(3)	(3)	(1)	2.8	35.6
Cuba	Habana	23 N. 82 W.	57	70	79	75	3.0	4.3	43.0
Czechoslovakia	Prague	50 N. 14 E.	656	29	66	48	1.1	2.6	19.5
Denmark	Copenhagen	56 N. 13 E.	43	32	62	46	1.3	2.6	21.5
Ecuador	Guayaquil	2 S. 80 W.	30	79	75	78	10.0	1.0	39.4
Egypt	Cairo	30 N. 31 E.	108	54	84	71	0.3	(1)	1.3

[1] Trace. [2] Sea level. [3] No record.

[4] Data from Commerce Yearbook, 1928, Vol. II. United States Department of Commerce.

Climatic Conditions: Important Cities of the World—Continued

Country	City	Latitude and Longitude	Elevation	Mean Temperature			Precipitation		
				January	*July*	*Annual*	*January*	*July*	*Annual*
		° °	*Feet*	°F.	°F.	°F.	*Inches*	*Inches*	*Inches*
Finland	Helsinki (Helsingfors)	60 N. 25 E.	38	22	62	40	2.1	2.5	26.1
France	Bordeaux	45 N. 1 W.	243	41	68	54	2.8	2.0	33.4
	Marseille	43 N. 5 E.	246	43	72	57	1.8	0.6	21.5
	Paris	49 N. 2 E.	253	37	66	51	1.4	2.0	20.8
Germany	Berlin	53 N. 13 E.	125	31	65	47	1.5	2.7	23.0
	Münich (München)	48 N. 12 E.	1,726	27	63	45	1.5	4.8	35.2
Greece	Athens	38 N. 24 E.	351	48	81	64	2.0	0.3	15.4
Hungary	Budapest	48 N. 19 E.	369	28	70	50	1.5	2.1	25.3
India	Bombay	19 N. 73 E.	37	75	80	79	0.1	25.0	74.0
	Calcutta	23 N. 88 E.	20	65	83	78	0.3	12.3	61.0
	Rangoon	17 N. 96 E.	20	75	79	79	0.1	21.4	99.0
Indo-China	Saigon	11 N. 107 E.	36	79	82	82	0.8	20.1	77.1
Iraq	Baghdad	33 N. 44 E.	128	49	92	71	1.3	(1)	9.0
Irish Free State	Dublin	53 N. 6 W.	163	42	61	50	2.1	3.0	28.0
Italy	Genoa	44 N. 9 E.	177	46	75	60	4.2	1.6	52.0
	Naples	41 N. 14 E.	489	47	76	60	4.0	1.0	33.0
	Rome	42 N. 12 E.	170	44	77	60	3.1	1.0	32.0
Jamaica	Kingston	18 N. 77 W.	33	77	82	80	1.0	1.5	32.5
Japan	Tokyo	36 N. 140 E.	70	37	75	57	2.0	6.0	58.0
Java	Batavia	6 S. 107 E.	26	78	78	79	13.0	3.0	71.0
Latvia	Riga	57 N. 24 E.	50	23	64	43	1.3	3.0	21.3
Lithuania	Vilna	55 N. 25 E.	486	22	66	44	1.0	2.4	16.1
Mexico	Guaymas	28 N. 111 W.	10	69	90	80	0.1	1.0	6.3
	Mexico	19 N. 99 W.	7,480	54	62	60	0.2	4.1	23.1
	Tampico	22 N. 98 W.	72	67	79	74	1.0	70.0	35.0
Morocco	Casablanca	34 N. 8 W.	56	53	71	63	2.0	(1)	17.0
Netherlands	Amsterdam	52 N. 5 E.	45	36	65	50	2.1	3.1	29.1
Newfoundland	St. Johns	48 N. 53 W.	125	24	59	40	6.3	4.0	57.0
New Zealand	Auckland	37 S. 175 E.	125	67	52	59	3.0	5.1	44.0
Norway	Oslo	60 N. 11 E.	82	24	63	42	1.1	3.0	23.2
Palestine	Jerusalem	32 N. 35 E.	2,447	44	73	61	6.3	(1)	26.0
Paraguay	Asuncion	26 S. 58 W.	312	80	65	73	7.0	2 2	54.1
Persia	Teheran	36 N. 51 E.	4,002	34	85	62	1.2	0.4	9.0
Peru	Lima	16 S. 77 W.	520	71	61	66	(1)	0.3	2.0
Poland	Warsaw	52 N. 21 E.	392	26	66	45	1.2	3.0	22.3
Portugal	Lisbon	49 N. 9 W.	312	49	70	60	4.0	0.2	28.7
Rumania	Bucharest	44 N. 26 E.	269	26	73	51	1.2	3.0	23.1
Russia	Irkutsk	52 N. 104 E.	1,532	5	65	31	1.0	3.0	15.0
	Leningrad	60 N. 30 E.	16	15	64	39	1.0	3.0	19.0
	Moscow	56 N. 38 E.	512	12	66	39	1.1	3.0	21.0
	Odessa	46 N. 31 E.	213	25	73	49	1.0	2.1	16.1
	Tomsk	57 N. 85 E.	400	−3	66	30	1.1	3.0	20.0
	Vladivostok	43 N. 132 E.	88	5	66	40	0.1	2.2	15.0
Siam	Bangkok	14 N. 101 E.	5	76	81	80	0.1	8.0	67.0
Spain	Barcelona	41 N. 2 E.	138	46	74	59	1.3	1.0	21.1
	Madrid	40 N. 4 W.	2,149	40	76	56	1.3	1.0	17.0
Sweden	Stockholm	59 N. 18 W.	144	27	62	42	1.0	2.4	19.0
Switzerland	Geneva	46 N. 7 E.	1,329	32	67	49	2.0	3.1	34.0
Syria	Beirut	34 N. 36 E.	108	56	80	69	7.5	(1)	36.0
Trinidad	Port-of-Spain	11 N. 61 W.	40	77	79	79	3.1	9.0	66.9
Turkey	Constantinople	41 N. 29 E.	246	41	74	58	3.4	1.1	29.0
Union of South Africa	Capetown	34 S. 18 E.	30	69	55	62	1.0	4.0	25.0
	Johannesburg	26 S. 28 E.	6,148	67	50	60	5.6	0.3	30.7
United Kingdom	Glasgow	56 N. 4 W.	180	39	58	47	3.3	3.1	37.2
	London	51 N. 0	76	39	63	50	1.8	2.6	25.1
Uruguay	Montevideo	35 S. 56 W.	96	72	50	61	3.1	3.0	37.8
Venezuela	Caracas	11 N. 67 W.	3,419	69	72	71	1.0	5.0	32.0
	Maracaibo	11 N. 72 W.	26	81	85	83	(1)	1.9	20.9
Yougoslavia	Belgrade	45 N. 20 E.	453	29	72	52	1.1	2.8	24.3

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[1] Trace.

Area and Population

Rounded figures are approximate only. Density is computed on basis of latest population figures, even when these are estimates. Asterisk (*) indicates the capital of the country.

81
63
18

COUNTRY	AREA, SQUARE MILES	LAST CENSUS		OFFICIAL ESTIMATES		DENSITY PER SQUARE MILE	LARGEST CITY	ESTIMATED POPULATION (THOUSANDS)
		Year	*Population (thousands)*	*Year*	*Population (thousands)*			
NORTH AMERICA								
United States (continental)	[1]2,973,774	1920	105,711	1928	120,013	40.4	New York	5,971
Alaska	590,884	1920	55	....	....	.1	*Juneau	3
Hawaii	6,449	1920	256	1928	312	48.4	*Honolulu	107
Canada	[1]3,654,200	1921	8,788	1927	9,519	2.6	Montreal	908
Mexico	760,290	1921	14,235	1927	1,500	19.1	*Mexico	633
Newfoundland	152,734	1921	263	1927	268	1.8	*St. John's	41
CENTRAL AMERICA								
British Honduras	8,598	1921	45	1926	48	5.6	*Belize	13
Costa Rica	23,000	1927	472	....	....	20.5	*San Jose	51
Guatemala	42,364	1921	2,005	1927	2,454	57.9	*Guatemala	116
Honduras	46,250	1926	701	1927	740	16.0	*Tegucigalpa	27
Nicaragua	49,500	1920	638	1927	650	13.1	Leon	38
Panama	32,388	1920	446	1925	500	15.4	*Panama	67
Salvador	13,176	1901	1,007	1927	1,680	127.5	*San Salvador	86
WEST INDIES								
Bermuda	19	1921	20	1926	29	1,526.3	*Hamilton	3
British West Indies	12,414	1921	1,729	1925	1,826	147.1	Kingston	63
Cuba	44,164	1919	2,889	1927	3,568	80.8	*Habana	581
Dominican Republic	19,332	1920	895	1927	1,022	52.9	*Santo Domingo	35
French West Indies	688	1926	243	....	....	353.2	Fort-de-France	40
Haiti	10,204	....	....	1927	2,550	249.9	*Port au Prince	125
Netherland West Indies Islands	403	....	....	1926	58	143.9	*Willemstad	18
Porto Rico	3,435	1920	1,300	1928	1,456	423.9	*San Juan	100
SOUTH AMERICA								
Argentina	1,153,119	1914	7,885	1927	10,647	9.2	*Buenos Aires	2,031
Bolivia	787,000	1900	1,816	1926	2,599	3.3	La Paz	110
Brazil	3,286,170	1920	30,636	1927	40,543	12.3	*Rio de Janeiro	1,400
British Guiana	89,480	1921	298	1926	307	3.4	*Georgetown	60
Chile	289,890	1920	3,754	1928	4,025	13.9	*Santiago	588
Colombia	495,500	1918	5,855	1927	7,283	14.7	*Bogota	202
Ecuador	110,000	....	....	1926	2,000	18.2	Guayaquil	100
French Guiana	34,069	1926	47	....	....	1.4	*Cayenne	14
Paraguay	176,000	1899	556	1927	1,000	5.7	*Asuncion	114
Peru	[2]521,513	1876	2,699	1926	5,500	10.5	*Lima and suburbs	260
Surinam (Netherland Guiana)	50,000	....	....	1926	143	2.9	*Paramaribo	46
Uruguay	72,172	1908	1,043	1926	1,720	23.8	*Montevideo	439
Venezuela	393,976	1926	3,027	1927	3,089	7.8	*Caracas	135
EUROPE								
Austria	32,368	1923	6,535	1925	6,700	207.0	*Vienna	1,866
Belgium	11,754	1920	7,466	1927	7,932	674.8	*Brussels	783
Bulgaria	39,825	1926	5,483	1927	5,597	140.5	*Sofia	213
Czechoslovakia	54,206	1921	13,613	1927	14,388	265.4	*Prague (Praha)	725
Denmark[3]	16,574	1925	3,435	1927	3,475	209.7	*Copenhagen	731
Estonia	18,359	1922	1,107	1928	1,115	60.7	*Tallinn (Reval)	129
Finland	[1]132,676	1920	3,365	1926	3,558	26.8	*Helsinki (Helsingfors)	216
France	212,736	1926	40,744	1927	40,960	192.5	*Paris	2,871
Germany	180,972	1925	62,592	....	....	345.9	*Berlin	4,024
Greece	49,165	1920	5,536	1926	6,825	138.8	*Athens	515
Hungary	35,875	1920	7,980	1927	8,522	237.5	*Budapest	929

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[1] Land area.
[2] Excluding disputed territory.
[3] Not including outlying possessions.

Area and Population—Continued

Country	Area, Square Miles	Last Census		Official Estimates		Density per Square Mile	Largest City	Estimated Population (thousands)
		Year	*Population (thousands)*	*Year*	*Population (thousands)*			
EUROPE (*Con't.*):								
Irish Free State	26,592	1926	2,973	....	....	111.8	*Dublin	419
Italy	119,744	1921	38,711	1927	40,799	340.7	Milan	878
Latvia	25,402	1925	1,845	1927	1,870	73.6	*Riga	338
Lithuania	21,490	1923	2,029	1928	2,286	106.4	*Kaunas (Kovno)	96
Netherlands	13,213	1920	6,865	1928	7,626	577.2	Amsterdam	735
Norway[3]	[1]119,653	1920	2,650	1927	2,789	23.3	*Oslo	252
Poland	149,957	1921	27,177	1927	29,589	197.3	*Warsaw	1,029
Portugal (including islands)	35,796	1920	6,033	1925	6,185	172.8	*Lisbon	530
Rumania	113,887	1912	[4]7,235	1927	17,709	155.5	*Bucharest	875
Russia (U. S. S. R.)	8,240,483	1926	146,989	....	....	17.8	*Moscow	2,026
Spain	195,040	1920	21,959	1926	22,128	113.4	*Madrid	800
Sweden	[1]158,525	1920	5,904	1927	6,088	38.4	*Stockholm	465
Switzerland	15,944	1920	3,880	1926	3,959	248.3	Zurich	211
United Kingdom	94,278	1921	44,170	1927	45,435	481.9	*London (Greater)[5]	7,796
Yugoslavia	96,737	1921	12,017	1927	13,160	136.0	*Belgrade	250
ASIA								
Afghanistan	245,000	....	....	1926	12,000	49.0	Herat	121
Arabia	1,000,000	....	....	1926	10,000	10.0	Mecca	70
Ceylon	25,332	1921	4,505	1926	5,125	202.3	*Colombo	262
China (Dominion)	4,300,000	....	....	1923	442,000	102.8	*Peking	1,181
China (proper)	1,900,000	....	....	1923	435,000	228.9		
India	1,819,000	1921	318,942	....	....	175.3		
British Provinces	1,107,968	1921	247,003	....	....	222.9	Calcutta and Fort	908
Indian States	711,032	1921	71,939	....	....	101.2	Hyderabad	404
Indo-China, French	284,900	1926	20,698	....	....	72.6	Cholon	199
Iraq	143,250	1920	2,849	1925	3,175	22.2	*Baghdad	170
Japan (Empire)	260,251	1925	83,458	....	....	320.7	*Tokyo (second city)	1,996
Japan (proper)	147,327	1925	59,737	1926	63,007	405.5	Osaka	2,115
Malaya, British	56,603	1921	3,358	....	....	59.3	Singapore	350
Nepal	54,000	1911	5,639	1926	5,600	103.7	*Katmandu	80
Netherland East Indies	733,649	1920	49,351	1926	51,718	70.5	*Batavia	306
Palestine	9,000	1922	757	1926	887	98.6	*Jerusalem	63
Persia	628,000	....	....	1927	10,000	15.9	*Teheran	240
Philippine Islands	114,400	1918	10,314	1928	11,922	104.2	*Manila	314
Siam	200,149	1920	9,207	1927	9,939	49.6	*Bangkok	931
Syria and Lebanon	74,500	....	......	1926	3,000	40.3	Damascus	250
Turkey (including European)	283,000	1927	13,650	....	....	48.2	Constantinople	807
OCEANIA								
Australia	2,974,581	1921	[6]5,436	1927	6,235	2.1	Sydney	1,070
New Zealand	[7]103,285	1926	1,407	1927	1,450	14.0	*Wellington	101
AFRICA								
Algeria	222,206	1926	[8]6,065	....	....	27.3	*Algiers	226
Anglo-Egyptian Sudan	1,015,000	....	....	1926	6,475	6.4	Omdurman	79
Angola (Portuguese West Africa)	484,800	....	....	1926	4,150	8.6	*Loanda	
Belgian Congo	921,000	....	....	1926	15,000	16.3	*Leopoldville	[9]1
Egypt	[10]385,000	1927	14,169	....	....	(10)	*Cairo	1,064
Ethiopia (Abyssinia)	350,000	....	....	1926	10,100	28.8	*Addis Ababa	60

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[1] Land area.

[2] Excluding disputed territory.

[3] Not including outlying possessions.

[4] Old boundaries.

[5] The area of Greater London is 443,449 acres. The area of registration London is 74,850 acres and the population 4,605,400.

[6] Excluding about 60,000 full-blood aborigines.

[7] Excluding outlying and annexed islands.

[8] Including 81,296 boarding-school students, soldiers, sailors, prisoners, etc.

[9] White persons only.

[10] Mostly desert. Occupied lands are estimated at about 12,300 square miles and on this basis the density would be 1,152 per square mile.

Area and Population—Continued

Country	Area, Square miles	Last Census		Official Estimates		Density per Square Mile	Largest City	Estimated Population (thousands)
		Year	Population (thousands)	Year	Population (thousands)			
AFRICA (*Con't.*):								
French Equatorial Africa	871,000	....	....	1926	3,125	3.6	*Brazzaville	
French West Africa.....	1,045,000	1926	13,542	....	....	13.0	*Dakar	40
Gold Coast............	80,000	1921	2,078	1926	2,300	28.8	*Accra	38
Kenya................	209,000	....	......	1926	2,605	12.5	Mombasa	40
Liberia................	40,000	....	....	1926	2,000	50.0	*Monrovia	10
Madagascar............	228,707	1926	3,621	....	....	15.8	*Tananarive	71
Morocco, French.......	200,000	1926	4,229	....	....	21.1	Morocco (Marrakech)	149
Mozambique (Portuguese East Africa)....	428,132	....	....	1926	3,120	7.3	*Lourenço Marques	13
Nigeria................	335,700	1921	18,152	1926	18,475	55.0	*Lagos	
Rhodesia..............	436,950	....	....	1926	2,078	4.8	Bulawayo	[9]8
Tanganyika............	373,500	....	....	1926	4,350	11.6	*Dar-es-Salaam	25
Tunisia................	48,332	1926	2,160	....	....	44.7	*Tunis	186
Uganda................	110,000	....	....	1926	3,160	28.7	*Entebbe	
Union of South Africa...	471,917	1921	6,929	1927	7,659	16.2	Johannesburg	315

Source: Department of Commerce; compiled from statistical publications of the individual countries.

[9] White persons only.

Appendix B

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